Location Intelligence:

A Decision Support System for business site selection

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September 2010

Thesis submitted in partial fulfilment of the requirements for the degree of Engineering Doctorate at UCL

Declaration

I, Patrick Weber, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature

Abstract

As one of the leading 'world cities', London is home to a highly internationalised workforce and is particularly reliant on foreign direct investment (FDI) for its continued economic success. In the face of increasing global competition and a very difficult economic climate, the capital must compete effectively to encourage and support such investors.

Given these pressures, the need for a coherent framework for data and methodologies to inform business location decisions is apparent. The research sets out to develop a decision support system to iteratively explore, compare and rank London's business neighbourhoods. This is achieved through the development, integration and evaluation of spatial data and its manipulation to create an interactive framework to model business location decisions. The effectiveness of the resultant framework is subsequently assessed using a scenario based user evaluation.

In this thesis, a geo-business classification for London is created, drawing upon the methods and practices common to geospatial neighbourhood classifications used for profiling consumers. The geo-business classification method encapsulates relevant location variables using Principal Components Analysis into a set of composite area characteristics. Next, the research investigates the implementation of an appropriate Multi-Criteria Decision Making methodology, in this case Analytical Hierarchy Process (AHP) allowing the aggregation of the geo-business classification and decision makers' preferences into discrete decision alternatives. Lastly, the results of the integration of both data and model through the development of, and evaluation of a web-based prototype are presented.

The development of this novel business location decision support framework enables not only improved location decision-making, but also the development of enhanced intelligence on the relative attractiveness of business neighbourhoods according to investor types.

Acknowledgements

I would like to extend my thanks to the many people that over the past six years have helped me directly and indirectly to complete this thesis. Although impossible to mention everyone, I would like to express my gratitude to the following people.

First, I must express my greatest thanks and appreciation to Dr Dave Chapman, whose initiative, knowledge and drive all through these years has kept me on track with my research and provided me with much needed encouragement and guidance that has enabled me to finish this journey. My gratitude also extends to my industry sponsor, Think London, who funded this Engineering Doctorate, providing me with both the case study of FDI investment into London and a supportive work environment for the best part of 5 years. In particular, this cooperation would have been impossible without the enthusiasm, professionalism and trust of Marc Hardwick in his role as Think London's research manager.

I would also like to thank Dr Muki Haklay for his academic and professional support over the years, as well as the many colleagues I have encountered at UCL in the Department of Civil, Environmental and Geomatic Engineering, Department of Management Science, the Bartlett School of Architecture, the Centre for Advanced Spatial Analysis and the Department of Computer Science. Special thanks for their professional and personal support to Dietmar Backes, Claire Ellul, Daryl Lloyd, Artemis Skarlatidou, Yi Gong, Erica Calogero, Mona Valerie, Ernesto Lopez and Nish Palawan. Thanks also to the many colleagues I met over the years at Think London who made it such an enjoyable workplace, including Abdul Halim, Zoe Slade, Wilman Leung, Dan Hawkins, Shipu Miah, Claire Shah, Andrea Phillips, Liz McFarland, Steven Spires and Judy Ng.

Thanks also to my friends in Luxembourg and London, my mother and father, as well as Judith and Peter, who have endured the last six years of work with me. Their support and friendship encouraged me during the highs and the lows.

Finally, but most importantly, my gratitude and love goes to my partner Kate. Her unconditional support and encouragement made this journey possible, and I will forever be grateful for her advice, both personal and professional!

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Glossary

Term	Definition
Clusters	A geographically proximate group of interconnected companies in a particular field.
Complete Spatial Randomness (CSR)	Describes a point process whereby point events occur within a given study area in a completely random fashion.
Consistency Ratio	The consistency of a pair-wise comparisons matrix is expressed by the Consistency Ratio (CR) As defined by Saaty (1990), if the CR is below 10% (0.1) the inconsistency of the pair-wise comparisons matrix is deemed acceptable.
Creative, Knowledge, and Entrepreneurial capital	The presence of a highly skilled, creative and innovative/entrepreneurial class.
Deprivation measures	Composite aggregate indicators, which provide comparable measures of deprivation for small areas.
Externalities (spillovers)	In economics, impact on a party that is not directly involved in the transaction. Mostly connected to positive effects, such as urbanisation/agglomeration economies, which affect all economic actors.
Geodemographic classification	Small area measure of shared socio-economic and lifestyle conditions based on social similarity and proximity.
Globalisation	The reduction and removal of barriers between national borders in order to facilitate the flow of goods, capital, services and labour. During this process, national resources become more and more internationally mobile while national economies become increasingly interdependent.
Human capital	The stocks of expertise and knowledge of the local labourforce.
Inward-investment / Foreign Direct Investment (FDI)	The injection of money from an external source into a region, in order to purchase capital goods for a branch of a corporation to locate or develop its presence in the region. See also Foreign Direct Investment (FDI).
Location Quotient	Represents ratio between the employment proportion locally and the national average of this proportion, identifying whether a sector is locally over-or underrepresented relative to the overall average.
M function	The *M* function allows for the comparison of an economic sector to the aggregate activity (represented by all sectors), as a cumulative function counting neighbours of points up to a given distance ***r***.

Term	Definition
Mashup	A web page or application that uses or combines data or functionality from two or many more external sources to create a new service.
Modifiable Areal Unit Problem (MAUP)	A problem arising from the imposition of artificial units of spatial reporting on point-based geographic phenomena resulting in the generation of artificial spatial patterns.
OpenLayers	An open-source JavaScript library for displaying map data in web browsers. It provides an API for building rich web-based geographic applications similar to Google Maps and Bing Maps.
Pair-Wise Comparison	In AHP, decision makers systematically evaluate the various decision hierarchy elements by comparing them to one another two at a time. In making the comparisons, the decision makers can use concrete data about the elements, or they can use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations.
Physical capital	The physical infrastructure supporting local economic activities, including public transport, utilities, road network.
Polycentricity	Refers to multiple interacting centres in a given urban area, either intra-urban patterns of clustering of both populations and economic activities (London, Paris, Los Angeles), or inter-urban patterns of activity such as the Dutch Randstad or the Ruhr Area.
R	A free software environment for statistical computing and graphics.
Rateable Value	Represents the open market annual rental value of a business/non-domestic property.
Social Capital	The networks, cultural norms, values and supports inside a local community.
Think London	London's official Foreign Direct Investment Promotion Agency.
UK Trade and Investment (UKTI)	A UK Government organisation, which supports UK-based businesses in international markets, promotes, and supports inbound FDI to the UK.

Abbreviations

Term	Definition
ABI	Annual Business Inquiry
AHP	Analytical Hierarchy Process
ASP	Active Server Pages
BID	Business Improvement District
CA	Conjoint Analysis
CSR	Complete Spatial Randomness
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GLA	Greater London Authority
ICT	Information and Communication Technologies
IMD	Index of Multiple Deprivation
KDE	Kernel Density Estimation
LDA	London Development Agency
LSOA	Lower Layer Super Output Area
MADM	Multi-Attribute Decision Making
MAUP	Modifiable Areal Unit Problem
MCDM	Multi-Criteria Decision Making
MIS	Management Information System
MSOA	Middle Layer Super Output Area
NEG	New Economic Geography
ONS	Office for National Statistics
PCA	Principal Components Analysis
RDA	Regional Development Agency
SDSS	Spatial Decision Support System
SIC	Standard Industrial Classification
SMART	Simple Multi-Attribute Rating Technique
TFL	Transport For London
VOA	Valuation Office Agency

1 Introduction

1.1 Thesis context

In a globalised economy, the economic competitiveness of a region, and hence its ability to attract and retain firms, is one of the main drivers of sustainable regional economic development. In seeking to attract inward investment, countries, regions, and cities compete aggressively to market their relative competitive advantages through a wide range of benchmarks, performance indicators, and “league tables” (Anholt 2006). These metrics consistently rank London as one of the top potential business destinations. However, London’s continued success as a major global city is critically dependent upon its ability to attract major new organisations to the city and its neighbourhoods. Thus, it is vital that the key factors driving London’s competitive advantage and its constituent neighbourhood characteristics are understood and effectively communicated to target businesses, specifically to foreign investors with little knowledge of London’s existing business landscape.

Since 1999, Think London has acted as London's official inward-investment agency. During this time, Think London has helped over 800 foreign companies set up operations in London, thus making an important contribution to London’s position as a major foreign direct investment target. The author developed for Think London a basic mapping capability to provide investors with information about London’s regions in easy to understand maps. Think London’s Geographical Information System (GIS) has proven to be a reactive tool, primarily used to confirm and support location choices already made by investors. This reflects the fact that so far, Think London has not yet put into place the tools and processes needed to understand the challenges facing investors looking to locate in London. The intra-city location decision-making for Foreign Direct Investment (FDI) investors is made more complex by their unfamiliarity with London’s dynamic and heterogeneous business landscape, resulting in the need for assistance from Think London in guiding investors to the optimal business location.

Recognising the need for a coherent framework for data, methodologies, and tools to inform business location decision-making, Think London, in collaboration with University College London, agreed to fund this author’s Engineering Doctorate scholarship. Given this industrial sponsor context, this thesis addresses the sponsors’ business needs through an applied research project to design a Spatial Decision Support System (SDSS) to guide and advise investors through the process of selecting an optimal business location in the Greater London area.

1.2 Problem definition and research justification

The rise of a globalised world economy, with a set of successful “World Cities” (Hall 1966), has resulted in increasing competition between regions and cities to attract investment from local, domestic, and foreign firms (Camagni 2002). The development of competitiveness frameworks of economic investment into regions and cities then qualifies the conditions for the attraction of investment, including both the strength of local clusters of co-locating competitors, suppliers, and local talent pool, enabling local ‘knowledge spillover’ between competing firms (Porter 2003). In addition, knowledge, creative, and social capital as supplementary externalities (Florida 2003; Kitson et al. 2004) are of critical importance to regional performance. Competitiveness frameworks then offer explanatory tools at the regional and city levels to define location characteristics and conditions deemed attractive to investors.

It should be noted that the attraction of investment and the generation of growth in a given city in this globalised world economy depends not only on the type of economic, social, cultural, or regulatory environment a city has to offer, but also on the specific demands and needs of different companies according to provenance, sector, or function. In the context of this thesis investigating FDI location decision-making, available research has been conducted at a number of different spatial scales - at national level, regions inside a given nation, and the city level. An apparent shortage of research is noted with respect to research investigating FDI location decision-making within cities, the smallest scale at which FDI decision-making occurs (Oum & J. Park 2004; Berkoz & Turk 2008). Isolated case studies of investment patterns exist for specific regions and cities, as well as specific sectors, but these studies fall short of the development of a comprehensive theoretical framework conceptualising the differential competitiveness of city neighbourhoods for foreign investors.

These research gaps in the understanding of business location decision-making at the intra-city scale contribute to a dearth of detailed intra-urban competitiveness frameworks qualifying successful neighbourhood characteristics. Factors contributing to these gaps in research include the lack of disaggregated datasets enabling the development of robust characterisations of neighbourhoods, as well as a lack of appropriate models of business location decision-making at the intra-urban scale, taking into account specific and individual investor requirements and preferences (Wu 1999). These individual requirements and preferences are also subject to the context and cognitive and psychological limitations of organisational decision-making (Simon 1976). Specifically for FDI decision makers, the unfamiliarity with London's dynamic and heterogeneous business landscape poses significant challenges. These shortcomings have meant that intricate and complex intra-city level location decisions by investors in the modern economy have not been investigated in detail widely thus far. These limitations in the understanding of FDI investment location decision-making also affect the organisations charged with supporting the establishment of new investors, such as Regional Development Agencies and specifically, FDI investment promotion organizations. These bodies also lack a comprehensive and formalised understanding of location decision-making, affecting the quality and efficiency of their services.

These knowledge and capability gaps are relevant specifically in the context of London, given the political push for more economic development being directed from the Central Business District to other urban and suburban areas of Greater London. Improved data, models, and tools enabling the effective promotion of intra-urban investment destinations according to individual investor's needs and demands is an area, which has significant research scope and applicability. Through the qualification and quantification of a consistent business neighbourhood data framework, applied to a relevant and flexible location decision model for business site selection, significant improvements can be achieved in the marketing and promotion of cities as business destinations, attracting new investors, and contributing to the economic success and competitiveness of neighbourhoods, cities, and regions.

1.3 Research goal, aims, and objectives

Given the limitations of current data models and methods in intra-urban business location decision-making, the major research goal of this thesis is to:

> *"develop a robust, spatially-enabled methodology for the quantification and qualification of intra-city business location decision-making."*

Although the goal of this thesis could be a generic framework for business site selection, given the applied research context of the thesis, the goal will be fulfilled through a case study of the development of a decision support system for foreign direct investment in London. The case study will inform the geographical extent of the spatial database, as well as the business location decision-making processes modelled. Given the complex and diverse nature of

London's business neighbourhoods, it is especially difficult for foreign businesses to comprehend the process of identifying advantageous business locations in London. As a result, the development of a comprehensive understanding of London's urban business environment offers a large opportunity to add value to inward investors' location decision-making processes.

The goal of developing a prototype implementation of such a decision support tool can be subdivided into the following three objectives, each subdivided into essential tasks:

1. To understand London's diverse and polycentric business environments:
    a. Identify relevant business location decision-making factors according to the literature review, competitiveness frameworks, investor surveys, and primary research;
    b. Discover a coherent, consistent, and relevant geographical framework modelling London's business neighbourhoods by which to integrate disparate spatial datasets representing identified business location variables; and
    c. Implement a geo-business classification of London neighbourhoods describing and distinguishing areas based on multifaceted business environment characterisations.
2. To formalise business location decision-making, qualifying and quantifying location preferences according to investor needs:
    a. Evaluate and implement an appropriate decision-making methodology to capture and analyse firms' business location decision-making preferences; and
    b. Develop a computational model integrating location preferences with the geo-business classification of London neighbourhoods, ranking and generating location recommendations.
3. To support business site decision-making through an integrated prototype system:
    a. Implement a dynamic and rich user interface for the system, guiding and supporting the user through the location decision-making process according to the model developed, allowing the geo-visualisation and exploration of location recommendations; and
    b. Evaluate the geo-business classification and decision support methodology through a user evaluation of the prototype's relevance and consistency of recommendations.

These three objectives and their constituent subtasks serve as a convenient structure for the development of the thesis document. However, the process laid out here makes it clear that the main contribution of this thesis to the overall research knowledge base lies in the innovative integration of disparate datasets, methods, and tools to arrive at a novel classification of London's diverse business neighbourhoods, applied in conjunction with a relevant formalisation of a business location decision-making process.

1.4 Thesis structure

The chapters of this thesis all contribute to the development of the research objectives and constituting tasks as laid out previously, and can be summarised in Table 1.

Table 1: Thesis structure in relation to research objectives

Chapter Title	Research Objectives
Literature review	1a
Evidence base for business site selection	1a
Research framework	1a,2a
Spatial Database	1b
Geo-business classification for London	1b,1c
Multi-Criteria Decision-Making model base	2a,2b
Prototype SDSS implementation	3a,3b

Chapter two, "Literature review", provides a contextual understanding of the historical, economic, and spatial processes which specifically address the role and place of cities as economic hubs of the world economy. This overview is expanded into a more detailed review of the general processes associated with business location decision-making, and more specifically, with spatial decision-making of FDIs at an intra-urban spatial scale. From the review of the business geography of London and its FDI promotion context, this chapter concludes that there is a lack of research into intricate and complex intra-city level location decisions by investors in the modern economy. This contention informs the research goal of a better understanding of business location decision-making in the context of the case study area, Greater London.

Chapter three, "Evidence base for business site selection", supplements and details the development of a relevant spatial database of business location variables, drawing on the conclusions from the literature review, which identified a set of business location variables at multiple spatial scales. This chapter builds on the previously presented review of relevant academic research in the context of business location decision-making, along with a competitiveness and branding framework for cities and third-party surveys to build a more detailed understanding of how sector, function, and corporate culture influence the decision-making process and location variables considered by firms. Together with primary research into FDI-relevant location variables for London, this chapter develops a unified data framework for business location decision-making.

Chapter four, “Research framework”, reviews relevant decision support frameworks, methodologies, and processes that support the research objectives of this thesis. This chapter identifies Spatial Decision Support Systems (SDSS) as the most relevant and appropriate methodology to fulfil the stated research goals. SDSS subdivide the implementation of the prototype system into four succinct components: a database, a model base, a computation base, and a user base. For each system component, a discussion of the requirements in terms of functionality, data requirements, and processes involved is presented. These requirements form the basis for the outline of a process and structure of the final system. The four SDSS components are presented in detail in the following chapters: the database (chapters 5 and 6), model base (chapter 7), and the computation base and user base (chapter 8).

Chapter five, “Spatial database”, combines the previously gained knowledge on location variables relevant to business decision-making with a relevant geographical framework of the case study area. This chapter details the development of the spatial database, including the evaluation of different data sources able to act as proxy indicators for the previously discovered location variables relevant to business location decision-making. The integration of these datasets into a spatial database and aggregation to a common geographic framework likely to model London’s business neighbourhoods is also discussed.

Chapter six, “Geo-business classification for London”, presents the development of the final database component of the SDSS. Taking advantage of methods and processes attached to geo-demographic classifications, this chapter details the implementation of a geo-business classification simplifying the existing spatial database of location variables, allowing the characterisation and classification of London’s diverse business neighbourhoods. The geo-business classification forms the database component of the SDSS, allowing investors to both gain a better understanding of London's diverse business neighbourhoods and aid business site location decision-making.

Chapter seven, "Multi-Criteria Decision-Making model base" (MCDM), presents the development of a relevant decision methodology model base as another fundamental component of the final SDSS. Through a review of a selection of relevant MCDM, discussing their merits and drawbacks, the Analytical Hierarchy Process (AHP) is selected as the most appropriate methodology. Through a preliminary implementation of AHP, fundamental issues with the methodology and computation of the location recommendations are evaluated to inform the further development of the final SDSS implementation.

Chapter eight, "Prototype SDSS implementation", brings together all the elements of the prototype SDSS, validating and informing the geo-business classification for business location decision-making. This implementation focuses on the functionality required for inward investment promotion decision-making, specifically in the context of inward investment promotion in London. The development of an efficient computation base environment, integrating a decision-making model and the geo-business database is presented, as well as the development of a web-based user interface allowing the efficient interaction between users and the system. The prototype enables the capture and processing of users preferences and the generation of potential solutions. The prototype's user-friendly interface (user base) that guides users through the decision-making process further enables the efficient visualisation of the complex business landscape of London. Through a scenario-based user evaluation of the system, the potential of the research methodology is evaluated, focusing on the consistency of outcomes for both expert and non-expert users, as well as general comments from users on the usability of the system.

The concluding chapter nine reflects on the achievements and limitations of the data, methodology, and outcomes presented in this thesis as well as on promising future avenues of development for the proposed system. Given the applied nature of this research and the commercial potential of business location decision-making support, a brief exploration of the commercialisation of this research project is presented, formulated around briefs for a product specification and a marketing and sales proposition.

2 Literature review

This chapter outlines the research context for this thesis, informed by a literature review of relevant academic work, focusing on seven thematic areas (summarised in Figure 1):

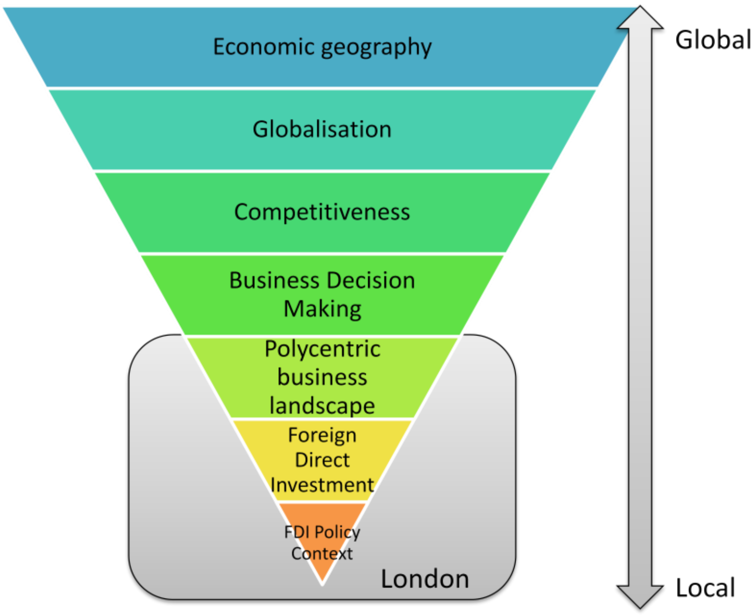


Figure 1: The seven components of the literature review

The literature review starts with a general overview of economic geography and agglomeration benefits impact on the formation and role of cities, the role of cities in today's globalised and competitive economic landscape, and an understanding of the scope of rational business decision-making in location choices. Together with the specific investigation of polycentricity of London's business neighbourhoods and the role and promotion of FDI in London, these themes of investigation inform the design and implementation of the research goals of this thesis. This ultimately leads to the development of a spatial decision support system for business location decision-making using FDI decisions in London, the research goal of this thesis.

2.1 Economic geography

Economic activities are not evenly distributed in geographical space, a fact that has been of interest to researchers ever since the advent of the first theoretical economic geography frameworks during the 19th century. This early work resulted in the development of economic geography models that seek to explain the resulting imbalances in economic spatial development, evident across many global cities, whereby some parts of a country, region, or city are more economically developed than others. Economic geography is a useful starting point for this literature review given that the causes and processes that drive competition for economic development between different nations, regions, and cities also manifest themselves at the intra-urban study scale of this thesis. The next section considers the historic development of economic geography thinking.

Economic geography as a formalised field of study first emerged through the development of economic geography theory in the 19th century. Von Thünen's book, "The Isolated State" (1826), exemplifies this development, proposing a mathematically rigorous model of spatial economics applied to the distribution and concentration of agricultural activities based on a set of productivity and cost-distance variables. The model results in a geography of concentric rings around a nucleus town, each producing different agricultural goods. In 1933 Christaller, a German geographer, developed his theory on Central Places in Southern Germany. Christaller's theory explains that given a set of assumptions including the economic rationality of all actors and a uniform population distribution, the economic development of a region will result in a hierarchical distribution of settlements in space. An example of the conceptualisation of this spatial structure can be seen in Figure 2. From this premise, the theory develops an economic landscape consisting of a hexagonal network of hierarchical settlements and connections between these settlements based on economic exchanges.

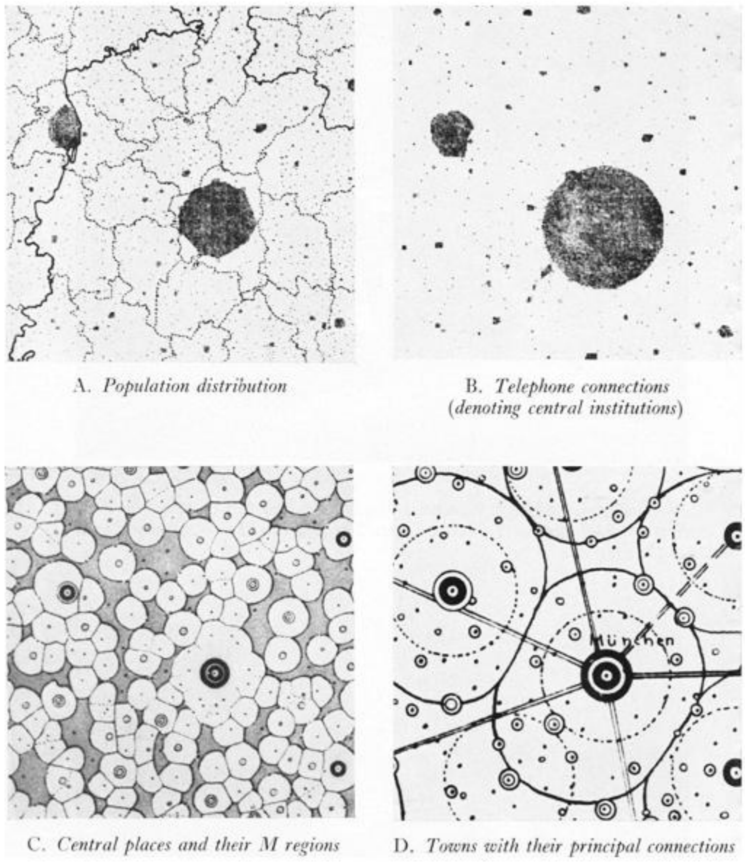


Figure 2: Stages in Christaller's recognition of a central place hierarchy[1]

Marshall’s “Principles of Economics”, (1890) focuses on the specific benefits firms draw from co-location with other firms in the same industry sector, i.e., the “localisation economies” of industry agglomeration. Marshall identifies three sets of localisation economies: (1) access to labour pools of skilled specialised workers, (2) maximising potential matches between specialised labour demand and supply, and (3) the availability of specialized inputs and services, including access to suppliers and customers:

> *“When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighbourhood to one another . . . Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require . . . The advantages of variety of employment are*

[1] Taken from Christaller (1933)

> *combined with those of localized industries in some of our manufacturing towns, and this is a chief cause of their continued growth." (Marshall 1890, p.350)*

The key to Marshall's model is that collocated firms accrue economic benefits primarily because of their geographical proximity. These "external economies" or "economies of agglomeration" are then the common explanatory elements that cause companies to group together (Gordon & McCann 2000). Marshall's seminal work in establishing a set of explanatory variables for agglomeration of economic activities provides the basis of most subsequent work on agglomeration economies. Hoover (1948) expands the concept of "*agglomeration economies"*, differentiating between three forces that shape the economic landscape:

1. Economies of scale, i.e. internal forces to the firm which for example, lead to a concentration of the activities of one firm in one large plant.
2. *Localisation economies* internal to industrial sectors - external co-location advantages that are sector-specific.
3. *Urbanisation economies*, i.e., increasing returns attributed purely to co-location of a large number of firms, irrespective of sector or size.

Weber (1929) integrates transportation cost savings as another agglomeration economy, resulting in minimized production costs. He also makes the case for the influence of natural advantages can have on the agglomeration potential, such as climatic and topographical suitability, proximity to raw materials, and locations with access to natural or manmade transportation routes (Glaeser et al. 1992; Bekele & R. Jackson 2006).

Marshallian (Marshall 1890) sources of agglomeration economies (labour market pooling, inputs sharing, and knowledge spillovers) rely on the spatial distribution of individual firms. Together with Hoover's framework, a web of entangled processes emerges, working to shape and shift on multiple scales the spatial configuration and development of economic activity. These multiple, overlapping and complex processes shape an economic landscape of alternating agglomeration and dispersion, both on multiple spatial as well as industry sector scales.

Building on the work of Marshall and integrating work by Arrow (1962) and Romer (1986), Glaeser et al. (1992) define the notion of "knowledge spillovers" as another set of agglomeration economies. These interlinkages inside a networked structure of customers, suppliers, competitors, and institutions, act as both pressure and incentive to an individual firm for knowledge upgrading and innovation, formal and informal exchanges of ideas, and knowledge that nurtures competition and growth. Glaeser et al. (1992) further found these effects to be more pronounced in more industrially diverse cities, suggesting that knowledge spillovers are beneficial not only inside a given industry, but also between industries.

In summary, the history of economic geography development in the context of agglomeration theory as developed by Marshall (1890), or “Classical Economic Geography”, can be attributed to a first generation of location models (Haggett 1967). These agglomeration economies models are concerned mainly with the economic integration of regions and cities through comparative advantages, such as external economies of scale, industrial linkages, and the mechanisms that give economic advantages to the individual firm located in close juxtaposition to other similar and related firms. These models then start from a more or less clean slate of landscape, travelling through a series of very deterministic cause and effect arguments fed into a logical engine, resulting in the predictable and repetitive patterns of the economic landscape.

The application of classic agglomeration theory was not only useful in the analysis and explanation of historic spatial patterns of economic development. This understanding of economic growth and concentration was applied to planned industrial developments, such as the growth pole (centre) policy of the 1960s and 1970s, essentially trying to attract companies to predefined industrial clusters[2] (Parr 1999). These growth poles ultimately proved to be a failure, unable to create and maintain a sustainable industrial cluster.

Building on and addressing some of the shortcomings of the previous work in agglomeration economies, “New Economic Geography” (NEG) emerged in the 1990’s. Work led principally by Krugman (1991; 1998) focused on connecting several strands of the “old” economic geography theories into a coherent mathematical modelling approach, specifically addressing

[2] Proponents of the concept saw benefits in increased concentration of infrastructure, a concentration of economic activity including industrial linkages, as well as increased economic growth. Parr argues that the concept of growth poles never lived up to its early promise, and was ultimately abandoned. The failure was attributed to the imbalance between “trickle-down effects” (Hirschmann 1958) of growth poles, for example through multiplier effects of secondary “hinterland” activities, versus polarisation or back-wash effects (Myrdal 1957) stemming from a concentration and integration of economic activity at the growth-pole, leaving the hinterland deprived of economic activities previously located there. These arguments are still valid today in the debate of industry clusters definition, importance, and impact on regional economic disparities.

globalisation's impact on the nature of cities as hubs of economic activity, the role of which will be expanded in the next section.

NEG aims to develop models suitable to explain a state of general equilibrium[3] and connect the economics of a city to the wider global economy. Krugman draws on advances in trade theory to update economic geography to reflect the changes experienced through globalisation, namely the "death of distance" and its impact on urban agglomeration. NEG endeavours to integrate both centripetal (centralising) forces, formalised in agglomeration models explaining the economic power and attraction of cities such as New York and London, and centrifugal (dispersion) forces, for example, transportation costs in a fixed input or output market, which enable sustainable rural communities to co-exist with cities in a state of relative equilibrium in a core-periphery model. Where previous frameworks failed to integrate these two opposing forces, NEG integrates these forces into one coherent modelling framework. The renaissance of economic geography and agglomeration theory through the work pioneered by Krugman also brought about a renewed interest in the role of external economies, such as labour markets, supplier networks, and knowledge spillovers. Krugman specifically takes into account the development of a new spatial view on international trade, the significant increases in regional integration, manufacturing relocation, and most importantly for this thesis, the growth of foreign direct investment, allowing for a better understanding of and integration of international trade theory (Ruggiero 2005).

[3] A general state of equilibrium in the economic sense of knowing where the money comes from and where it goes (Krugman 2000).

2.2 Globalisation

This section introduces the changing nature of the global economic system, and specifically the impacts of globalisation on the role of cities as hubs of the new global economic order. It also seeks to provide the contextual understanding of the most significant new determinants for the rise of a new world order of world cities, in particular the rise of FDI as a significant determinant of cities' economic success.

> *"The economic health of every country is a proper matter of concern to all its neighbours, near and far."*[4]

Even after more than 60 years, this quote by the President of the United States of America Roosevelt, still has resonance today. After the devastating world wars of the first half of the 20th Century, the politicians of the Allied nations met at the " Bretton Woods Conference" in 1944 to discuss the new monetary and trade world order. The conference was a pivotal moment in the integration of the world economy, laying a framework for international commerce and finance, and signalling the founding of several international organisations, such as the International Monetary Fund and the World Bank. Thus, the ideas and concepts behind *economic globalisation* were already in motion long before the term was defined and became widely used in the 1960s. The economic and political impact of globalisation has been defined as:

> *"...the reduction and removal of barriers between national borders in order to facilitate the flow of goods, capital, services and labour. During this process, national resources become more and more internationally mobile while national economies become increasingly interdependent" (OECD 2005).*

In this context, globalisation is a process of change, generated through a combination of increasing cross-border activity and information technology, enabling everyone, everywhere, to access the world's best resources, services, and knowledge (Hotz-Hart 2000, p.438). This process of change results in four broad economic effects:

1. The expansion and deepening of international trade of goods and services;
2. An increase of international transfer of financial capital, including crucial foreign direct investment by trans-national companies;

[4] President Roosevelt (1944) at the opening address of the Bretton Woods Conference.

3. The internationalisation of products and services by such firms; and
4. The development of rapid transfers of patterns of production and consumption between countries.

With consideration of these effects, the following question needs to be answered: '*How do these global political, economic, and social changes impact the spatial development and role of cities*?'

2.2.1 The role of cities in a globalised world

The role of cities, and by extension, of geography, in a globalised economy has been analysed by a number of authors. For example, in 2005 the Organisation for Economic Co-operation and Development (OECD) published a provocative thesis documenting the "death of geography in a global financial market-place which is destroying national frontier lines and other demarcation lines" (OECD 2005). The impacts of globalisation were also analysed in Friedman (2005) book, "The World is Flat". For Friedman, "flat" really means "connected" - the lowering of trade barriers and political barriers, along with revolutionary technological advances in communications and the digital revolution have removed traditional barriers for businesses as they become more easily connected. It is tempting to assume that this removal of barriers, and the death of distance through technological advances such as telecommunications, means that the role of geography matters less and less. By that logic, the previously discussed dispersal forces would weaken agglomeration and the economic importance of cities, resulting in a wider dispersal of economic activities and the weakening of cities as centres of economic activity.

In fact, the rise of globalisation since the 1970s has encouraged heightened geographic differentiation and localisation specialisation (A. J. Scott 2001). Krugman's NEG specifically links globalisation with reinforced agglomeration effects expressed as increasing returns, trade costs, and factor price differences, resulting in the most productive economic city-regions becoming more profitable and thus attracting ever more investments (Behrens & Robert-Nicoud 2009). Globalisation thus engenders the rise of the city-region, not nation-states, as the spatial foundation of the new world system. In this new global network of urban centres, city-regions of global importance fulfil several functions, such as hosting the command posts of multinational corporations and serving as centres of advanced services, specifically of knowledge-intensive business services (also see Hall 1966; Friedmann & Wolff 1982; Sassen 2001).

An early example of the academic work aiming to explain and summarise the rise of this new global order of cities was Friedmann's "*world city hypothesis*" (1986). Friedmann defines a system of "world cities", used by global capital as hubs of production and markets. Countries are relegated to a hierarchy of "core countries", "semi-periphery countries", and "periphery countries", with world cities only located in core or semi-periphery countries. Urban development is driven by functions in a small set of expanding sectors, such as corporate headquarters, international finance, global transport, and communications, as well as high-level business services. Cities act as major centres of concentration and accumulation of international capital. Cities are also centres of production and dissemination of information, news, entertainment, and culture. Other authors, such as Castells (1996), Beaverstock (2000), and Sassen (2002) have revised, expanded, or developed their own models of world cities, taking into account developments since the 1980s, including the breakdown of the Eastern Block and the rise of India, China and other emerging markets.

A recent, updated example of a world cities classification is the "World City Network" dataset, produced by Taylor et al. (2009) (see Figure 3). This classification defines a hierarchical world city network, defining a global competitive environment in which cities thrive and compete for investment.

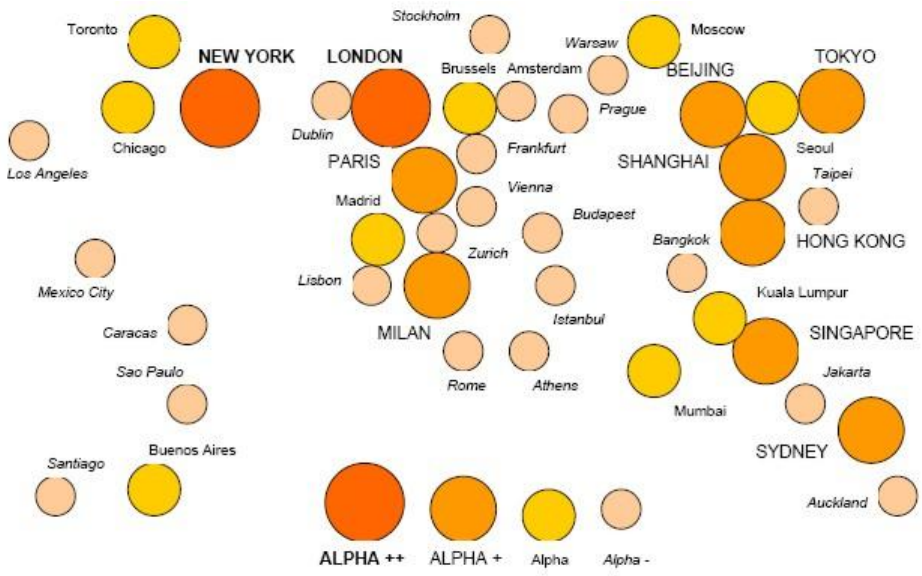


Figure 3: "World City Network" classification map for 2008[5]

[5] Taken from Taylor et al. (2009). This research identifies three tiers of world cities, Alpha, Beta, and Gamma. In the figure, only "Alpha" world cities are depicted, and sorted into four sub-categories.

The rise of this new global urban regions system means that today, global economic activity is concentrated in the world's largest cities. A separate classification of the top hundred world cities (see Table 2 for the top 30 cities), according to their economic power, shows that these cities now account for 30% of global GDP, and some have bigger economies than medium-sized countries like Sweden or Switzerland (PriceWaterhouseCoopers 2008). This is obviously a dynamic system, and changes in the global economic system, for example in developing countries, encouraged by business practices such as outsourcing of activities can change the picture of the global urban system in the near future. The impact of economic, political, and social-cultural changes in the world on this network of world cities also needs to be evaluated. A very good example is the global financial crisis of 2007, which developed over the past 3 years in parallel with the development of this research project. The impact of the recent crisis on FDI flows is detailed in the following section.

Table 2: Top 30 cities in 2008 by GDP, including projections for 2025[6]

Rank 2008	Cities ranked by estimated 2008 GDP at PPPs	Est. GDP in 2008 $ bn	Rank 2025	Cities ranked by projected 2025 GDP at PPPs	Est. GDP in 2025 ($bn at 2008)	Proj. GDP growth rate (% pa: 2009-2025)
1	Tokyo	1479	1	Tokyo	1981	1.7%
2	New York	1406	2	New York	1915	1.8%
3	Los Angeles	792	3	Los Angeles	1036	1.6%
4	Chicago	574	4	London	821	2.2%
5	London	565	5	Chicago	817	2.1%
6	Paris	564	6	Sao Paulo	782	4.2%
7	Osaka/Kobe	417	7	Mexico City	745	3.9%
8	Mexico City	390	8	Paris	741	1.6%
9	Philadelphia	388	9	Shanghai	692	6.6%
10	Sao Paulo	388	10	Buenos Aires	651	3.5%
11	Washington DC	375	11	Mumbai (Bombay)	594	6.3%
12	Boston	363	12	Moscow	546	3.2%
13	Buenos Aires	362	13	Philadelphia	518	1.7%
14	Dallas/Fort Worth	338	14	Hong Kong	506	2.7%
15	Moscow	321	15	Washington DC	504	1.8%
16	Hong Kong	320	16	Osaka/Kobe	500	1.1%
17	Atlanta	304	17	Beijing	499	6.7%
18	San Francisco	301	18	Boston	488	1.8%
19	Houston	297	19	Delhi	482	6.4%
20	Miami	292	20	Dallas/Fort Worth	454	1.8%
21	Seoul	291	21	Guangzhou	438	6.8%
22	Toronto	253	22	Seoul	431	2.3%
23	Detroit	253	23	Atlanta	412	1.8%
24	Seattle	235	24	Rio de Janeiro	407	4.2%
25	Shanghai	233	25	San Francisco	406	1.8%
26	Madrid	230	26	Houston	400	1.8%
27	Singapore	215	27	Miami	390	1.7%
28	Sydney	213	28	Istanbul	367	4.2%
29	Mumbai (Bombay)	209	29	Toronto	352	2.0%
30	Rio de Janeiro	201	30	Cairo	330	5.0%

2.2.2 The role of Foreign Direct Investment (FDI)

The rise of this new network of globalised city-regions has been made possible through globalisation, and today FDI constitutes an important part of a world city's economic success. FDI is defined as overseas investment in production by firms based in other countries, including the establishment or acquisition of plants, factories, and offices (MacKinnon & Cumbers 2007, p.95). Over the past 50 years, FDI has emerged as a new and decisive determinant of economic growth and success. As such, the role of transnational corporations

[6] Adapted from PriceWaterhouseCoopers (2008). Estimates and projections use UN population data and definitions. Growth rates in final column relate to the cities ranked by projected GDP in 2025 in the fifth column of the table. PPP = Purchasing Parity Power; pa = per annum.

as the drivers of economic development has changed significantly since the post-war period. Whereas in the past, transnational corporations used to be primarily engaged in international activities through arm's length export and import activities, FDI today is "not driven by trade, but largely determines trade" (Dunning 1994). Nowadays, FDI is widely accepted as surpassing international trade, becoming the most important driver of economic integration (Dicken 2003, p.52). FDI is now one of the leading drivers of the rise of a new class of world cities, notably including London.

The recent history of FDI flows was thoroughly investigated by Dunning & Lundan (2008). The authors found that the structure, distribution, and benefits of FDI have changed significantly since the 1970's. During this period, South and East Asia and Central and Eastern Europe gained a significantly increased share of inbound investment, with the European Union showing modest gains. While the Americas, West Asia, and Africa recorded increased inbound FDI investments, they lost out in terms of the absolute distribution of total global investment. In the 1980s, four countries (US, UK, West Germany, and the Netherlands) accounted for 73% of outward investments. The nature of major FDI contributors has also changed significantly since the 1990's, with 14 countries representing the major (78%) contributors to outward investments since the 1990s. Although developed countries remain the largest contributors, with the United Kingdom in third place behind France and the Netherlands, there have been significant increases in outward investment from developing and transition economies such as Hong Kong, Singapore, Taiwan, China, Brazil, and Russia (Dunning & Lundan 2008, p.27).

Dunning attributes the overall growth of FDI over the past 40 years to the renaissance of the market economy and the creation of common markets such as the European Union (EU) and the North American Free Trade Agreement (NAFTA), resulting in the liberalisation, deregulation, and privatisation of markets, which led to significantly reduced trading costs for goods, services, and assets. Contributing to the lower trading costs were also significant advances in electronic communications technologies. Lower international trading costs also meant that access to markets and resources enabled increased competition between firms on a regional and global level, as opposed to a national level. Competitive pressures meant that transnational corporations faced the reorganisation of their activities on a global scale, resulting in relocation of functions such as research and development, outsourcing of production and support functions, as well as increased transnational mergers and acquisitions.

According to the most recent report by the United Nations (2009), since 2008 the global financial crisis has significantly affected global FDI flows. The crisis has meant that global inflows have been dropping significantly since 2008 ($1.7 trillion), and were projected to bottom-out in 2009, to a level of $1.4 trillion. The crisis has significantly affected global flows: investments to developing and transition economies surged (43% of global FDI flows); there was a large decline in FDI flows to developed countries (29%); inflows to Africa rose to a record level (a 63% increase over 2007); inflows to South, East, and Southeast Asia experienced a 17% expansion; FDI to West Asia continued to rise for the sixth consecutive year; inflows to Latin America and the Caribbean rose by 13%; and the expansion of FDI inflows to Southeast Europe and the Commonwealth of Independant States (CIS), i.e. the former Soviet Republics, rose for the eighth year running.

The benefits of FDI have to date been investigated primarily at the level of inbound host countries (Caves 1996). Borensztein et al. (1998), for example, studied the effect of FDI on economic growth for developing countries, noting the positive effects of FDI. FDI was found to provide more growth than indigenous investment, and represents a vehicle for technology transfer, given a certain threshold of human capital by which the host country can retain the benefits. A more detailed look into the benefits of FDI reveals that transnational corporations today are the main producers and organisers of knowledge-based assets and innovative activities, such as research and development, in the global economy. Transnational corporations shape economic progress and systemise and disseminate new knowledge and organisational techniques, increasing efficiency, productivity, and regional economic growth (Dunning 1994; Mullen & Williams 2005). These benefits accrue because foreign firms must have advantages that allow them to overcome the higher costs of becoming a multinational company (Hymer 1976; Girma et al. 2001).

FDI not only presents benefits to multinational companies, but it also increases the competitiveness of the host country's economy in a number of ways (Dunning 1994; Girma et al. 2001):

- More efficient production of goods and services through a reduction of organisational costs or raising labour or capital productivity;
- Innovation and the introduction of new products or improvements to existing products or services;
- Opening new foreign markets to investors; and

- Being more responsive, in terms of costs, speed, and flexibility, to structural adjustments in changes in global demand and supply conditions.

Conversely, there also has been work in looking at adverse effects of FDI. Specifically in the USA, Graham & Krugman (1995, p.4) note that there is resentment and fear that foreign ownership and investment will adversely affect employment and trade, leading to a shift of skills and jobs away from the USA. Despite the downsides, the authors consider both views of this argument and come to the conclusion that the benefits of FDI for an industrialised nation outweigh the negatives.

2.3 Competitiveness

In a globalised economy, characterised by a class of world cities attracting increasing amounts of growth and investment, all cities and regions compete for the attraction of local, domestic, and significantly, foreign economic investment (Camagni 2002). Globalisation opened competition not only between firms, but also between cities, regions, and countries. At the same time, many comparative advantages set at the nation level, such as monetary policies, and flexibility of wages and prices, have been reduced through initiatives such as for example common trade markets and currencies, resulting in the free movement of people, goods, services and capital (the European Union being one obvious example).

Given this global competition, the conditions a city needs to present to be able to attract and retain investment from both domestic and foreign firms have arisen as a significant research topic. Research seeking to explain why some nations or regions are more successful than others at attracting foreign investment has been formalised in explanatory city competitiveness frameworks. The following section aims to give a review of some of the recent competitiveness frameworks for general economic investment. Given the focus of this thesis on FDI as one of the main sources of investment into cities (and London specifically), a systematic review of the authors who have specifically looked at FDI investments is conducted to shed light on the empirical evidence relating to the specific factors (variables) which affect inward investment into specific places.

2.3.1 Competitiveness frameworks

In a globalised world, the re-emergence of absolute competitive advantages as the definitive factors influencing FDI firms' location decisions on a region or city level has been significant (Camagni 2002). These include superior technological, social, infrastructural, or institutional regional assets, which all contribute to firms' competitiveness, thereby increasing productivity. Apart from these absolute competitive advantages, the importance of agglomeration economies, also emerge as highly relevant.

Simmies (2001), in his book "Innovative Cities", gives a detailed account of the drivers of innovation in cities, one of the key components of economic competitiveness and a driver of growth and prosperity in cities. He lists several influential theories that have formed to frame and explain the drivers of innovation. The most influential models are attributed firstly to Schumpeter's work (1934) in highlighting innovation as the main driver of dynamism in the economy. Clustering of activities is attributed mainly to agglomeration economies such as access to labour, materials, capital, and energy supply, with the key drivers driven mostly by small and entrepreneurial companies. Rapid technological and institutional change puts the focus on a corporation's flexibility, which can be achieved through spatial division and specialisation of labour and R&D, enabling corporations to thrive and contribute to the development of an innovative milieu.

One of the most influential modern innovative milieu theories was formulated by Porter (2003) who argues that the strength of regional economies is strongly correlated to the strength of local clusters (a geographically proximate group of interconnected companies in a particular field). By co-locating near competitors and suppliers it is argued that firms can rapidly tap into the established ecosystem of specialist suppliers of goods and services, knowledge pools, and spillover effects along with competition advantages. Porter's work has been widely adopted by UK regional development agencies (Porter & Ketels 2003) and has been very influential in shaping regional economic policy.

In the present post-industrial globalised economy, the re-emergence of small and entrepreneurial companies has been investigated specifically in the context of the innovation and knowledge transfer. Chesbrough (2003) states that the traditional company internal closed-loop innovation cycle is dead. Companies big and small now need to rely on a new paradigm, "Open Innovation", leveraging internal and external sources of ideas to innovate and open their R&D, thus establishing new opportunities for collaboration, exchange, and buying of external resources, ideas, knowledge, and products.

A consequence of the new paradigm for innovation is the reinforcement of the importance of clustering as a driving factor for the attraction of investment, mimicking the agglomeration theory in the establishment of industrial districts, enabling the formation of informal knowledge spillovers, and the localisation of specialised labour markets.

Importantly, many academics have questioned whether the current emphasis on clusters as foci for growth represent a partial and incomplete view of regional development (Martin & Sunley 2003). For example, Florida (2003; 2005) argues that companies locate in specific areas to take advantage of local knowledge pools and hence rapidly mobilise talent that can fuel innovation and competitiveness. Florida places greater emphasis on the capabilities and qualities of the local community. He proposes three fundamental factors that contribute to a supportive environment for successful regional development:

- **Talent**: and more specifically, the development of an educated creative class as the driving force behind the now dominant knowledge economy;
- **Tolerance**: the creation of local communities that embrace openness, inclusiveness, and diversity for all ethnicities, races, and walks of life; and
- **Technology**: a function of the concentration of high-tech and innovative companies in the region, i.e. the presence of strong local industry clusters.

Kitson (2005; Martin & Sunley 2003) provides additional evidence of the importance of local knowledge, learning, and creativity as supplementary externalities that are of critical importance to regional performance. He extends and groups these factors to the following categories:

- **human capital:** the quality and skills of the labour force;
- **creative, knowledge, and entrepreneurial capital:** the presence of a highly skilled, creative and innovative/entrepreneurial class;
- **social capital:** the development and vitality of social networks; and
- **physical capital:** an adequately developed infrastructure to support all activities.

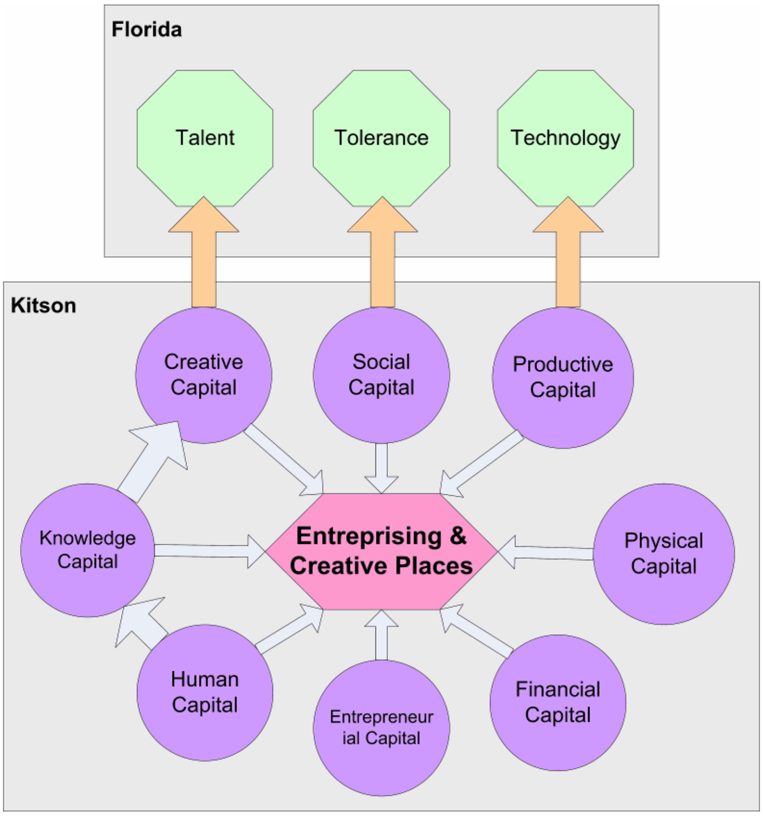


Figure 4: Regional development framework combining Kitson (2005) and Florida (2003) models for creative cities

By comparing Kitson's framework for regional competitiveness with Florida's model (see Figure 4), overlapping factors can be identified that cities and regions might employ to differentiate themselves from competitors. These variables help explain the rise of a thriving world city and the types of environments and conditions that are deemed to be attractive to both domestic and foreign investors. In the following section, the focus will be on the distinguishing characteristics and location variables connected to FDI investments.

2.3.2 FDI location variables

Competitiveness frameworks have emerged as an explanatory tool to help define location characteristics and conditions, applicable at the national, regional, and city level, which can explain either the success or failure of cities economically, as well as some of the reasons for their differing attractiveness to investment flows. However, these frameworks fail to make a conscious distinction in their models between domestic and foreign investors and have been developed and applied at a geographical scale of regions and cities as a whole. Specific research into the causes and effects of FDI within both the regional and city levels must be considered, providing a more detailed understanding of the distinct FDI needs and demands of locations from within host cities. The attraction of investment and the generation of growth inside a given city then depends not only on the type of social, cultural, or regulatory environment a city has to offer, but also on the specific demands and needs of companies looking to invest. Therefore, the outcome of this analysis will be a multi-level model of location variables affecting competitiveness at the geographic scales of nations, regions, cities, and neighbourhoods.

The available research for FDI business decision-making has been conducted at a number of different spatial scales from the national level, to more or less generalised regions inside a given nation, to the city level, and the intra-urban level. A summarised literature review is presented here that explores FDI location decision-making from the national level down to the intra-urban spatial scale, specifically noting a considerable shortage of research that actually investigates FDI location decision-making within cities, the smallest scale at which FDI decision-making occurs. Most of the current research into FDI location characteristics has been done at the spatial level of nations or regions, as supported by work done by Oum & Park (2004) and Berkoz & Turk (2008) in their systematic reviews of FDI location decision-making literature. An extensive body of research exists that has looked at FDI investments in different host nations and regions, examining a set of either industry sectors, such as manufacturing, logistics, business services, or specific markets, i.e., France, Germany, Poland, and Italy.

Looking first at FDI investment choices at the host nation scale, a set of common location variables were found to be relevant to FDI location decision-making. Inbound FDI decision-making was influenced mainly by: (1) size of market and economic growth rate, (2) market access factors and market potential , (3) manufacturing productivity, (4) labour costs and unemployment rates, (5) the extent of unionisation of the workforce, (6) geographical proximity of the host country to the home country, (7) government policies towards foreign investment, and (8) infrastructure quality and technological capability of the host country (Wheeler & Mody 1992).

At the regional scale of FDI investment decision-making, the location variables are similar, including market access and demand potential, labour market characteristics, and the quality of infrastructure and transport networks. The attractiveness of regions to FDI investors is also defined by the existence of pre-existing FDI industry clusters (Porter 2000; Cheng & Kwan

2000). Previous investments are deemed to have a positive self-reinforcing effect consistent with the agglomeration effect identified by (Head & Ries 1996) in their investigation of city choice for FDI in China, meaning FDI companies will seek regions and cities with pre-existing FDI clusters (Wheeler & Mody 1992) . Specifically, the FDI investment patterns of French firms are presented by Procher (2009), who examines French FDI investment abroad. Procher found that agglomeration effects from the existing presence of French firms in a given country positively attract new investments, and thus lead to agglomeration economies. This view is also repeated in studies of FDI in Poland (Cieslik 2005) and Italy (De Propris et al. 2005).

The investigation of agglomeration economies amongst FDI investors has attracted criticism in the past because of crude measurement methods, for example using total manufacturing employment as a proxy for specific industry agglomeration economies, as well as highly aggregated regions (US states), making spatial co-location of firms a very vague concept (Guimarães et al. 2000; Coughlin et al. 1991). A notable study sharpening the focus on this issue was done by Smith & Florida (1994). The authors defined a set of detailed regions (US counties) and a very specific FDI population (Japanese car manufacturing) to see if there are specific agglomeration economies affecting FDI investment decisions. In this clearly defined case study, there was significant evidence that Japanese car manufacturing firms locate in proximity to suppliers in order to enable the manufacturers to profit from external spatial economies and the just-in-time inventory system.

Crozet et al. (2004) took a more detailed spatial definition of regions and looked at foreign firms' location decisions on a regional level in France (90 territorial units). The authors were particularly interested in spatial patterns of co-location between firms of the same nationality and/or same industry sector. A regression analysis was developed incorporating factors such as demand at location; costs; number of other foreign firms, either from same country, overseas or France; distance to home market; and finally, local public policy context. The findings of the study revealed that there were indeed clustering effects linking firms from either the same industry sector or the same nationality. Industry clustering was explained mainly by perceived positive agglomeration effects, such as knowledge spillovers for spatial clusters of activities in specific sectors. As for common national firms, new firms tended to start out in France close to their home market (for example, a German company locating close to the German border), before moving on to locate closer to their French consumers.

Apart from regional clusters of activities in the same sector or from the same FDI source country, regional regulatory and tax incentives can play a positive effect as well, as demonstrated for China as a FDI recipient (Head & Ries 1996; Cheng & Kwan 2000), where Special Economic Zones and their tax benefits act as significant positive attractors of FDI.

Specifically for the UK, Hill & Munday (1992) identified a scarcity of studies looking at foreign investment at a sub-national level in the UK, along with a lack of appropriate measures on the nature and level of inward investment into the UK and its regions. Hill & Munday investigated the success of certain regions of the UK in attracting FDI. Apart from the previously presented regional level location variables, they also identified the potential effectiveness of regional policy as a guiding tool to ensure a more even distribution of FDI and its benefits to different regions of the UK. Jones & Wren (2008) investigated the effectiveness of grants for FDI investment at the regional level in the UK. They found that grants have a significant positive influence on FDI investors into the UK, but also noted that the influence of regional grants has declined since the 1990's. Both the Hill & Munday and Jones & Wren studies only addressed FDI investment distribution at a regional level, crucially lumping together London with the wider South-East, and did not address FDI investment at an intra-urban level.

Extending beyond the regional view of FDI investments, the spatial scale of individual cities and their constituting urban areas or neighbourhoods offers the most detailed view of FDI location decisions. Wu (2000) offers one view on FDI investment into Guangzhou, and offers a specific look at location dependant variables which influenced the location choice. First, Wu found, as other studies have, that there is pronounced clustering of FDI resulting from location factors such as transport networks (highway accessibility), labour availability, distance to the Central Business District (CBD), quality of the local infrastructure (hotels, communications), as well as the regulatory environment, in this case special trade zones and business parks, set up by the Chinese government inside the city.

In a later paper, Wu & Radbone (2005) distinguish FDI industry sector-specific location variables for Shanghai. For example, services FDI tends to locate close to existing clusters of services, while manufacturing FDI is attracted to specific government-designated zones, such as industrial and commercial parks. Turkish authors (Berkoz & Eyuboglu 2007; Berkoz & Turk 2008) studied the spatial distribution of FDI in Istanbul specifically for services and manufacturing. They found that FDI service companies were attracted by a good quality infrastructure, co-location with existing services firms, and access to a qualified workforce.

Manufacturing type businesses were attracted to the suburban areas because of the availability of a larger pool of cheap labour, along with accessibility to major transport hubs, such as railway and harbours. Corroborating evidence from a study (Ihlanfeldt & Raper 1990) not specifically targeted at FDI, identifies similar location effects. Specifically, Ihlandfelt & Raper identify a significant influence of support services on the location choices of new independent office firms. FDI investors entering a new market can be described as similar to new independent firms, lacking the pre-existing support service networks, such as banks, accountants, and lawyers that existing firms already have established.

Specifically for the UK, and London, Keeble & Nachum (1999; 2000; 2002; 2003) looked in more detail at both foreign and indigenous business services and media firms and their clustering behaviour within London. They found significant clustering behaviour, with the business services located in Central London as a highly integrated industry cluster, driven by accessibility to clients, both local and global, through London's excellent travel links. These benefits stand in contrast to areas outside of London, where decentralised firms do not have these advantages. For the media sector, Keeble & Nachum (2003) identify a similar, even more localised cluster in Soho, a neighbourhood in the West End of London, with companies looking for extensive and deep connections between firms in the localised sector cluster, taking advantage of external economies benefits.

2.3.3 FDI location decision-making framework

In summary, a review of studies looking at FDI-relevant location variables reveals three distinct spatial scales of investigation presented in the literature. For both the national and regional scale, FDI location decision factors have been widely studied through empirical surveys and models helping to elicit a comprehensive picture of relevant location variables, which have been summarised in a multi-level framework seen in Figure 5.

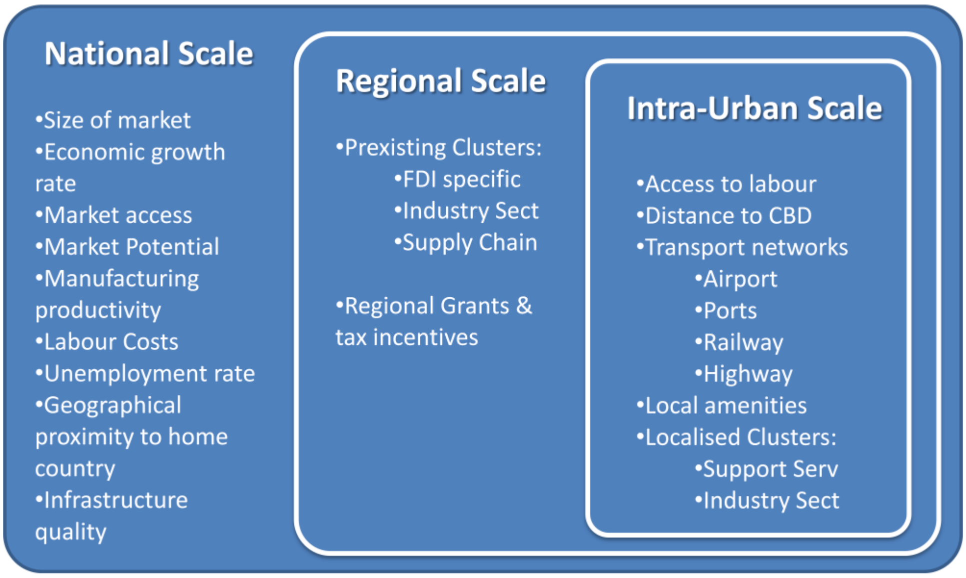


Figure 5: FDI location decision variables multilevel framework

For studies, which have gone past detailed regional investigations of FDI relevant location variables, there is a distinct scarcity of research exploring decision factors for FDI at the intra-urban level (Berkoz & Turk 2008). Some reasons for this dearth of detailed intra-urban studies might include the lack of disaggregated data and appropriate models. This lack of data has meant that supposedly intricate and complex decisions surround intra-city level location decisions in the modern economy have not been investigated in wide detail. However, these decisions matter not only to understand the urban neighbourhood characteristics needed for the attraction of FDI investment, but they are also fundamental to the understanding of the social and spatial transformations of urban areas.

2.4 Organisational and business decision-making

Apart from the previously discussed specific location variables that might sway FDI investors to a specific location over a set of alternative locations, general decision-making processes in businesses also need to be considered. Any FDI investments will have been decided by a firm, and more specifically, the managers in charge of the FDI investment project. Background knowledge of organisational decision-making processes should prove useful in understanding how to model location decision-making. Specifically, the issue of imperfect or irrational decision-making, as an effect of the cognitive and psychological factors influencing human actors, is investigated in this section in the context of decision support.

In organisational decision-making, the main actors are business managers whose work consists mainly of making decisions, communicating them to others, and monitoring the consequences. Managers' decisions will expose behaviour that ranges between two extremes: decision-making that is well structured, deliberative, and quantitative, in other words rational decisions, versus decision-making that is loosely structured, intuitive, and qualitative or non-rational (Simon 1987, p.57). Several authors have expanded and further specified this fundamental dichotomy of decision-making. Keen & Morton (1978) refer to these two extremes of the spectrum of decision structures as "structured" and "unstructured." Simon argues that looking at managers' decision-making styles, will reveal a continuum involving both intuitive and logical decision-making, influenced chiefly by the nature of the problem(s) to be solved.

Another model, proposed by Barnard & Andrews (1968), expands on the two models of decision-making processes: logical decision-making where the goals and alternatives are made explicit, and the consequences of alternatives are calculated and evaluated against the goals, versus non-logical or judgemental decision-making, where the need for a decision is immediate, without a detailed analysis of the decision-making process or the grounds for the chosen alternative. In the realms of economics or management science, Barnard's logical decision-making can be equated to the concept of optimisation, meaning evaluating and choosing the alternative with the best overall value and outcome. Most normative economic theory, such as laws of market equilibrium or supply and demand, is built on the concept of rationality, i.e., that man will always seek the optimal solution to a problem (Marakas 1999).

Despite the attractiveness of optimisation as a decision-making strategy, its application in business is problematic. Business executives, as opposed to scientists, do not often enjoy the luxury of making decisions on the basis of orderly, rational, and logical analysis, but rather depend largely on non-logical responses to decision-demanding situations, often attributed post-hoc by the decision maker to his intuition and/or experience (Simon 1987, p.57). The source of these intuitive or judgemental processes is grounded in the physical and social environment impressed upon decision makers unconsciously, as well as the mass of facts, pattern concepts, techniques, and abstractions generally referred to as formal knowledge or beliefs formed by the decision maker dependant on his experience, study, and education (Barnard & Andrews 1968). Simon agreed with Barnard & Andrews, but wanted to qualify these intuitive and subconscious decision-making processes, exposing their qualities and limitations.

The different nature of management decisions versus scientific analysis is also expressed in the fact that management decisions are often distinctly qualitative in nature, making the application of quantitative optimisation techniques impossible. Simon recognized the cognitive restrictions imposed on decision makers, who are after all only mere humans, leading him to the conclusion that these limitations make objective evaluation of all alternatives impossible, leading to the abolition of the rational "homo economicus"[7], a previously fundamental economic tenet. From these restrictions, he also developed a better understanding of how decision makers deal with these cognitive limitations, culminating in the concept of bounded rationality, modelling how decision makers deal with a given problem space:

> *"The human being striving for rationality and restricted within the limits of his knowledge has developed some working procedures that partially overcome these difficulties. These procedures consist in assuming that he can isolate from the rest of the world a closed system containing a limited number of variables and a limited range of consequences." (Simon 1976, p.82)*

In practice then, a decision maker is faced with a very wide and poorly defined problem space, containing a number of alternatives, good, bad, and great, as well as the *best* solution for the problem (see Figure 6). Through the concept of bounded rationality, Simon states that instead of evaluating every possible alternative in the problem space, decision makers will develop an understanding first of what an acceptable solution would look like, and then search for such an acceptable alternative. Most likely, the search will end before the whole problem space has been evaluated, thus creating a smaller search space of evaluated alternatives inside the problem space.

[7] Herbert Simon is the leading scholar of the 20th century in organisational decision-making. He was one of the first to discuss this concept in terms of uncertainty, i.e., it is impossible to have perfect and complete information at any given time to make a decision. For his work, he was awarded the Nobel Prize in 1978.

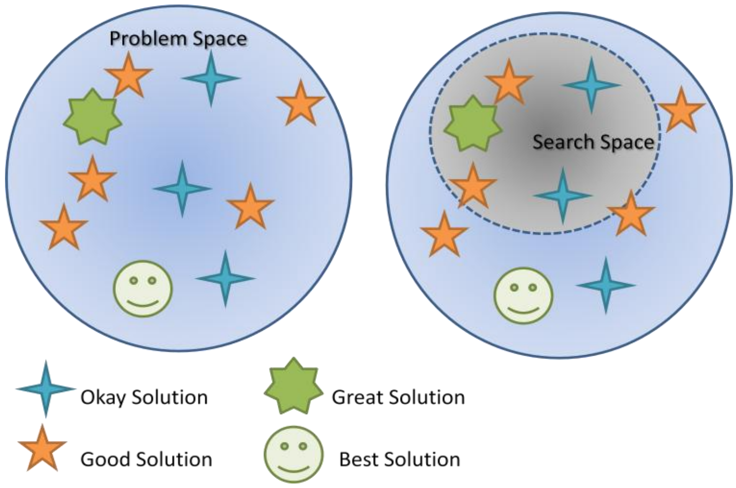


Figure 6: Schematic representation of the concept of bounded rationality[8]

The process of choice inside the search space presents pitfalls limiting the rationality and the ability of a decision maker to objectively find the best solution. Cognitive limitations, incomplete or inaccurate information, and resource restraints all limit the possible solution space during the choice phase. Specific cognitive limitations include:

- **Perception**, the filter through which facts must pass, built from personal experience, goals, values, beliefs, motivations, and biases, leading to difficulties in properly isolating the problem, delimitating the problem space too closely, being unable to see the problem from different perspectives, stereotyping, and cognitive overload ; and
- **Judgment**, drawing from experience, values, perception, and intuition, which when made in isolation without comparison and evaluation of alternatives, is nothing more than a guess that is blurred by the cognitive limitations of perception (Marakas 1999, p.73).

Individual decision maker's characteristics, likely to vary significantly between actors, act as further limitations, summarised in Table 3, making the entire process fraught with difficulties:

> *"There can be little doubt that human frailty pervades the act of choice and renders the entire decision-making process amenable to scrutiny and question at virtually every point" (Harrison 1999, p.58).*

[8] Adapted from Simon (1976).

Table 3: Characteristics of decision problems and decision makers[9]

1. Unfamiliarity	Degree to which decision task is foreign to decision maker
2. Ambiguity	Degree to which decision task is unclear to decision maker
3. Complexity	Number of different components to decision task
4. Instability	Degree to which decision components change during or after choice
5. Reversibility	Degree to which choice can be reversed if outcome appears undesirable
6. Significance	Importance of choice to both decision maker and the organisation
7. Accountability	Degree to which decision maker is culpable for choice outcome
8. Time/Money	Constraints on decision process and solution set
9. Knowledge	Amount of relevant knowledge possessed by decision maker
10. Ability	Degree of intelligence and competence of decision maker
11. Motivation	Desire of decision maker to make a successful decision

In conclusion, it is fair to say that the process of business location decision-making in the context of FDI is bound by the same constraints previously detailed as components of the general business decision-making process. Specifically, FDI decision makers will, on top of the generic cognitive limits exposed in the previous section, expose specific compounding psychological limits (see Table 3), such as: unfamiliarity (1, 2, and 9) with London's dynamic and heterogeneous (3 and 4) business landscape, as well as the importance (6) of the location decision (7 and 8) for establishing a successful presence in London.

In this context, the value and potential of a spatial decision support systems to support and guide inward investors through the location decision-making process is clear and will be further expanded in Chapter 4 – "Research framework".

[9] Adapted from Harrison (1999)

2.5 London's context

The literature review developed an understanding of the processes driving the economic success or failure of regions and cities as a whole in the context of a globalised network of world cities. Inside this network, a review was conducted of location characteristics sought by FDI investors at several spatial scales, as well as some limiting factors in how FDI actors can make rational location decisions. This review justifies the rational for development of a spatial decision support tool to support such decisions. Leading from this general understanding of location decision processes and variables, this literature review now focuses on the proposed case study area, Greater London.

London, the UK's only "world city," with 7.5 million inhabitants, representing approximately 15% of England's population, is one of the key cities in the global economic landscape. From this understanding of the city as a whole and its role in the world economy, the economic landscape of London, and specifically its diverse and polycentric business neighbourhoods, is investigated in the next section, focusing on the distribution of economic activities and specifically the clustering of different industry sectors and FDI. Given the dependence of London's economic competitiveness on the continued attraction and retention of FDI, a review of the policy context of FDI promotion activities in London will conclude this chapter.

2.5.1 London, a polycentric geo-business landscape

> *"One of the most interesting features of modern urban landscapes [is] the tendency of economic activity to cluster in several interacting centres of activity" (Anas et al. 1998, p.1439)*

For the last two hundred years, cities' spatial development has been primarily marked by a movement to spread out from a central nucleus of activity, often referred to as the Central Business District (CBD). However, this process of decentralisation has in recent decades taken on a different pattern, with a number of concentrated centres of employment influencing the spatial structure of integrated urban regions in terms of economic activities and population distribution. Polycentricity refers to this notion of multiple interacting centres in a given urban area and has become one of the strongest defining characteristics of urban landscapes in advanced economies (Kloosterman & Musterd 2001). Polycentricity can either refer to intra-urban patterns of clustering of both populations and economic activities (London, Paris, Los Angeles), or give rise to inter-urban patterns of activity such as the Dutch Randstad or the Ruhr Area. There is contention in the distinction between these two definitions, as the observation scale is different. Polycentricity can be explored at different spatial scales. For example, the view of London as an intra-urban polycentric city can change to be considered an inter-urban polycentricity when looking at the scale of the South-East of England (see Figure 7) as an integrated system of cities (Hall & Pain 2006).

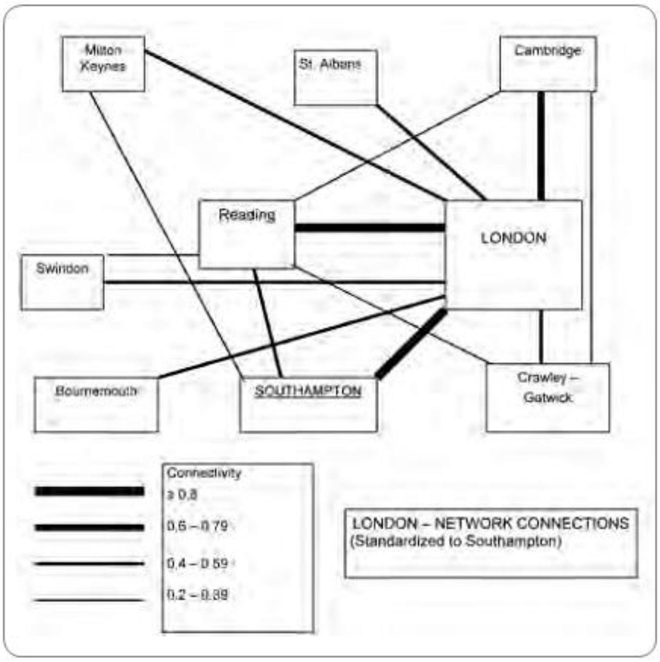


Figure 7: South-East England as an inter-urban polycentric system[10]

In particular, regarding the intra-urban scale of polycentricity, planning restrictions imposed in most western European cities have curtailed the growth of possible megacities in recent years, enabling decentralisation and enhancing sub centres and peripheral settlements (Hall 2003). These developments have contributed to the emergence of new forms of urban and suburban development, such as secondary business districts like La Defense in Paris, or Canary Wharf[11]

[10] Taken from Hall & Pain (2006)

[11] The Docklands used to be part of the largest port in the world, serving London's economy with goods and intercontinental transport links. But the 1960s saw a paradigm shift with the containerisation of the shipping trade, and in the 1970s, most of the ships moved to deepwater ports, e.g. Tilbury and Felixstowe, leaving a large area of derelict land in the East of London. A good account of the redevelopment of the Docklands can be found in the book "London, More by Fortune Than Design" (Hebbert 1998). Credit Suisse in the mid 1980s, looking for a new site for back offices, led proposals for the development of a new business district on the former West India Docks in Docklands. The developer, Olympia and York, constructed the first buildings, including the skyscraper One Canada Square, on the site. However, the development went into administration as soon as construction was finished in 1992 due to an oversupply of office space following the stock market crash of 1987. The development lingered, isolated from the

in London, designed specifically for the growing knowledge-intensive business services sectors. Retail and commercial parks next to transport links such as orbital motorways, or close to other good transport links such as airports, thrive to serve logistics, manufacturing, retail, and office functions. In addition, suburban town centres that in the past had primarily served the local needs of the nearby residential population have been able to include a variety of retail, public service, and back office functions offering businesses good transportation links into the city centre and competitive property rates.

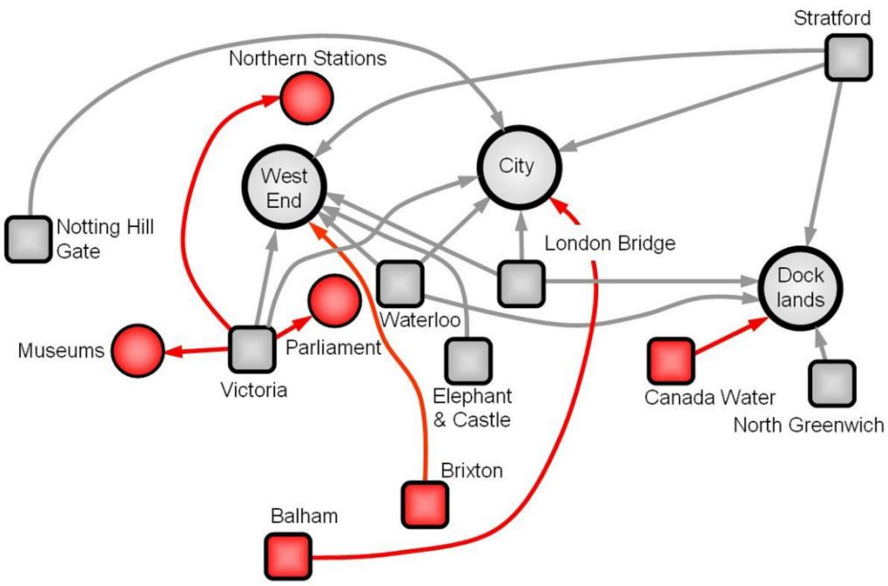


Figure 8: Daily commute flows between London town centres[12]

A recent effort to characterise the polycentric nature of Central London through an analysis of commuter flows (Roth et al. 2010), provides more evidence of the polycentric nature and

City of London, until a new international consortium, Canary Wharf Ltd., took over the development in 1995. Further transport infrastructure improvements, most notably the Jubilee Line extension, meant that in the late 1990s, Canary Wharf finally realised its potential and convinced major companies, including Barclays, HSBC, Citigroup, and Clifford Chance, to relocate their activities. Today there are over 100,000 people working in Canary Wharf, contributing to the increase in land values in and around the Isle of Dogs. Canary Wharf also is a symbol of the changing economic landscape of London, a viable economic competitor to the City of London, irrevocably shifting London's centre of gravity eastwards, signifying the possible future regeneration of the East of London and the Thames Gateway.

[12] Taken from Roth et al (2010). Squares represent sources of commuting flows, while circles represent commuting destinations. Grey flows/nodes represent 20% of total flow, while red flows/nodes represent 40% of total flows.

connections between nodes in this urban network, even on the small spatial scale of Central London, often considered a monolithic entity. The structure of aggregated daily commuting patterns presented in Figure 8 highlights a structure of commuting sources and destinations [13], showing a hierarchy of three main centres (West End, City of London, and Docklands) as well as secondary commuting destinations corresponding to areas such as Museums, Northern Stations, and Parliament.

A pan-London analysis of the nature and characteristics of London's intra-urban polycentricity[14] has been investigated to a very detailed degree through the development of the Town Centre Statistics Project (Thurstain-Goodwin et al. 2001; Lloyd 2004), looking to define an Index of Town Centeredness – thresholds which define town centre boundaries constrained by size and functional activity. The project took into account the historic evidence of London's urban development, with Greater London coming into existence as a construction of many individual towns and cities (Hebbert 1998; Thurstain-Goodwin & Unwin 2000; Ackroyd 2001; URBED 2002). These nuclei of urban development still survive today and have separate identities and differing characteristics, in an economic sense, as well as socially, demographically, and culturally, representing evidence of the persisting polycentric nature of London's urban and economic development. Greater London then only comes into existence as an intra-urban polycentric urban construct, defined by the activities and interconnections between these nuclei. In London in particular, over 200 town centres were identified, characterising the complex and polycentric nature of Greater London in terms of their economic, social, and cultural activities.

The economic agglomeration of activities, in other words, "industrial clustering," in and around these urban nuclei in London is evidenced by the fact that around 80% of all London employment is concentrated in and around town centres. Industry clusters thus become a specific expression of the uneven agglomeration of economic activities, and a defining characteristic of London and its urban spatial structure. Industry clusters can at the simplest conceptual level be defined as the co-location in space between economic actors. Going beyond this very basic definition there is a lot of contention and confusion regarding what an

[13] In this analysis restricted to the Tube network.

[14] So far there has not been a clear definition of economic polycentricity apart from density thresholding-based methodologies (Roth et al., 2010), which were the basic methodology employed by the Town Centre Statistics Project (Thurstain-Goodwin & Unwin 2000) to define town centres for London.

industry cluster is, with numerous prominent authors such as Porter (2000; 2003) and Krugman (1991) using the term in a variety of different ways.

Three views of urban concentration currently attract attention (GLA 2010b, p.31). The first view encompasses early urbanisation diversification effects (Jacobs 1970), also see van der Panne , (2004), which suggest that unrelated firms from different industry sectors are attracted to co-locate to a given urbanised area based on common benefits, such as transport infrastructures, technological complementarities, and access to markets or materials.

Contrasting this view of inter-sector clustering mechanisms, a second “Marshallian” (Marshall 1890) view looks at specialisation as the source of agglomeration economies arising from the co-location of firms of a specific sector, promoting labour mobility between firms, local “collective learning” networks and explicit inter-firm collaborations (Keeble & Nachum 2002; De Propris et al. 2009). Steinle & Schiele (2002) go on to define these strong linkages as a process of development of locally rooted value creating systems. Such a cluster system can then be defined as localised industry sector agglomerations of symbiotic organisations, which can achieve superior performance through interactions with each other.

A third dimension has been developed by Porter (2003), looking at the benefits of inter-industry connections, defined as linkages, which lead to Porter’s definition of clusters as:

> *“Geographic concentrations of interconnected companies and institutions in a particular field which encompass an array of linked industries and other entities important to competition”*

Porter’s definition, like many other definitions, is characterised by the absence of any specific geographical limit or scale, as well as no apparent strict delineation of industries. Thus clusters as a spatial and industrial entity remain vague (Martin & Sunley 2003).

Regardless of the competing definitions of industrial clusters, the consensus among authors is that economies of agglomeration and network effects are key explanatory variables for the emergence, growth, and success of a cluster of innovations and innovators (Breschi & Malerba 2005). Thus, it can be argued that these economies of agglomeration and network effects represent a key component of business location decision-making.

From this general look at clusters, the next question is whether the concept of clustering and agglomeration economies is applicable to a global knowledge economy, and specifically to

London. Sassen (2001; 2002) specifically notes that in the new global network of world cities, knowledge-intensive services clusters located in these cities offer exceptional advantages for developing and fostering global links, through world cities' unrivalled international travel and telecommunication networks, as well as their role as international hubs of knowledge.

Bennett (1999) states that in Britain, business services firms are highly concentrated into clusters, with this clustering pattern being most pronounced in London, which is the most highly focused cluster of all. More specific studies of sector clusters in London focus primarily on those sectors composing the post-industrialised knowledge economy. Nachum & Keeble (2000; 2002; 2003) looked in more detail at both foreign and indigenous business services and media firms and their clustering behaviour within London. For the business services in London, they note a genuine cluster of interconnected activities between firms in Central London, involving high levels of local inter-firm collaboration, knowledge acquisition, development, networking, and labour mobility. They argue that the cluster is driven by access to clients, both local and global, through London's excellent travel links. These benefits stand in contrast to the outside of London, decentralised firms, which do not benefit from the same effects to the same degree.

In their study of the media sector in London, Nachum & Keeble (1999) report that approximately 70% of total UK media sector employment is concentrated in London[15], and more specifically, they identify the West End and Soho as clusters of media-related activities. They focus their analysis on the film sector, which operates in an even more localised cluster of about one square mile in Soho, concentrating over 80% of film producers, distributors, and related services. In this highly localised cluster, the authors find high levels of local inter-firm collaboration, resulting in extensive and deep connections between firms in the localised sector, maintaining and promoting the aggregation benefits, which attract new investors to the Soho cluster.

[15] A more recent study by the GLA looking at the wider "Creative Industry" sector found that 32% of the creative workforce is employed in Greater London, and about 60% in the South East of England.

Table 4: Geographic concentration index of industry sectors in London[16]

Industry Sector	HH Index
Film and Video	19.70%
Financial Intermediation	14.20%
Arts and Antiques	9.90%
Radio and Television	6.50%
Utilities	5.70%
Advertising	4.90%
Publishing	4.20%
Architecture	3.10%
Transport	2.40%
Fashion	2.10%
FBS	1.60%
Music and Performance	1.50%
Public Administration	1.40%
Health and Social Services	1.10%
Construction	1.00%
Manufacturing	0.70%
Other Services	0.70%
Education	0.70%
Total Creative Industries	0.70%
Wholesale and Retail	0.60%
Leisure Software	0.40%
Hotels and Restaurants	0.40%
Business Services	0.30%

Evidence of the very highly localised nature of the film sector can be found in another study of the creative industry workforce in London (GLA 2010b), which investigated geographical concentration according to the Hirfindahl-Hirschmann index[17] (HHI) on the Medium Layer Super Output Area (MSOA) level (summarised in Table 4). Researchers found that the film sector has the highest geographic concentration at 19.7%. The study also looked at other industry sectors, which exhibit significant geographic concentration levels among other

[16] Adapted from GLA (2010b).

[17] The Hirfindahl-Hirschmann (HH) Index compares the geographical concentration of a specific industry with that of jobs as a whole.

$$HH = \sum_i (s_i - x_i)^2$$

with: s_i = share of district i in all jobs ; x_i = share of district i in jobs in a specific industry creative industry subsectors, as well as utilities, financial intermediation, business services (financial services). The authors theorise about possible linkages, for example those existing between certain sectors of the creative industry (advertising, architecture, and software) and financial and business services, which represent the client base of those creative industry firms.

In conclusion, it seems fair to state that industrial clusters do matter, as evidenced by both the data and models put forward by researchers. However, the reasons and propensity for different industry sectors to cluster can vary significantly. The reasons for co-location range from weak effects such as common urbanisation benefits to strong linkage effects working at an inter- as well as intra- sector level to generate agglomeration economies.

2.5.2 Foreign Direct Investment into London

London's economic strength over the past 50 years is intrinsically linked to the global liberalisation and globalisation that has transformed London's economy. Building on past traditions as an international centre for trade, commerce, and finance, London's economy has been able to profit from globalisation to become not only one of the wealthiest cities in Europe, but also one of the most important world cities.

According to the latest figures from the Government Office for London (2008), London's economy as a whole represented a Gross Value Added (GVA) of £217 billion in 2006, making the Greater London Area one of the major drivers of the UK economy, disproportionate to its share of the UK population of only 12.4% (Government Office for London 2008). The city's exports in goods and services were an estimated £58.7 billion in 2007, equivalent to more than one-fifth of the size of the capital's economy. Tourism accounts for £22 billion in additional revenue and over 250,000 jobs (LDA 2010).

Between 1998 and 2004, FDI contributed 42% of London's economic growth, which represents a yearly addition to London's economy of £52 billion. FDI accounts for more than 500,000 jobs in London, representing 13% of all jobs (Think London 2006a). London is one of the most important world cities in terms of its GDP (see Table 2), along with other cities in the first tier of world cities such as New-York, Tokyo, and Paris.

This position as one of the leading world cities is also acknowledged in business surveys such as the European Cities Monitor (Cushman & Wakefield 2009), that concluded that London remains in the top position for Europe, with Paris and Frankfurt as second and third, defending its position as the most important European world city over the past ten years. The survey provides an overview of the perceptions that corporate decision makers have about European cities. In the survey, London ranks as the top-rated city in half of the 12 major rankings, including easy access to markets, transport links with other cities and internationally, ease of travelling within the city, availability of qualified staff, quality of telecommunications, and languages spoken.

London is one of the leading centres of the world in international finance, hosting some of the key financial markets, as well as offices representing 300 international banks. Over 100 of Europe’s 500 largest companies are headquartered in London, as well as important clusters of business service companies such as law firms, and accountancy and consultancy businesses (Think London 2006a). London is also a leading world centre for creative industries and life sciences, and constitutes a tourism magnet for the UK.

The continued success of and status of London as one of the leading world cities is dependent on the continued investments by inward investors. The following section examines how London’s government is shaping this success.

2.5.3 London’s policy context

Government policy obviously plays a major role in the shaping of cities (Anas et al. 1998, p.1428). Although the UK has traditionally been portrayed as a classic unitary state, since 1997 there has been a far-reaching constitutional reform towards a “new regionalism” in the UK (Pearce & Ayres 2009). This “new regionalism” involved the creation of an elected Parliament for Scotland, Assemblies for Northern Ireland and Wales, and a Greater London Authority (GLA), which led to the establishment of a GLA mayor. The GLA was established as a governing body for the whole of London, constituted by 32 London Boroughs, as well as the City of London Corporation. The GLA is governed by an elected mayor, and an elected 25-member London Assembly with scrutiny powers. The City of London retains a Lord Mayor, which today is largely a ceremonial role, with not much real political or administrative power. Although formal administrative and political control of the GLA only extends to its boundaries, the economic, social, and cultural influence and draw of London can be felt on a regional level across the whole of the South East and other bordering regions, as well as internationally.

Along with the creation of the GLA, the focus on the delivery of regional policy through decentralisation also led to the creation of Regional Development Agencies (RDA) in 1999, and specifically, the creation of the London Development Agency in 2000, working under the GLA. The mission of the RDAs, and thus the LDA for London, is to stimulate and promote economic development and the reduction of disparities in economic growth rates between the most successful (London, the East and South-East) regions and the rest of the UK. RDAs were tasked with the following statutory purposes (Regional Development Agencies 2009) :

1. to further economic development and regeneration;
2. to promote business efficiency, investment, and competitiveness;
3. to promote employment;
4. to enhance the development and application of skills relevant to employment; and
5. to contribute to sustainable development.

As part of the mission to further the economic development and regeneration, and given that FDI is one of the most important drivers of the UK region's economic success, all RDAs devote significant resources towards the attraction, promotion, and retention of FDI actors in their respective regions. The marketing of London as a business destination, as well as the support of FDI investors in setting up in London, has been a focus of policy since the inception of the LDA, and remains a primary target of the mayor's economic development policy:

> *"... London is a global magnet for talent and business, fuelling a virtuous economic circle. The most successful commercial cities will tend to attract the most talented people. The deep pool of talent enjoyed by global centres of excellence propels innovation, putting them in an unrivalled position to create and exploit new markets. For a global leader, the market is the entire world, increasing the customer base and giving greater opportunities for the highest-level specialisations, which are only viable at the global level. ... Being a world leader creates more wealth for London and the UK. Globalisation builds on London's natural advantages and especially its geographical position - enabling it to do business with the whole world in a single day - and the increasing use of English as a business language throughout the world." (LDA 2010, chap.1.4) "*

Think London, an agency promoting London to foreign-owned businesses, is part of this effort to maintain London's position as a global centre of excellence. Created as a dedicated not-for-profit private-public partnership, Think London is financed mainly by the LDA and the City of London, but also receives income from a network of private sector commercial partners. Apart from its main office in London, the company has a network of international offices in Beijing, New York, San Francisco, and Mumbai, and works with UK Trade and Investment's global network of partners and representatives. Think London also works also with a sub-regional partner network in London, subdividing Greater London into 5 regions - North, East, South, West, and Central. According to the latest data available from their annual report for 2008-2009, Think London has helped 178 inward investors to establish operations in London, resulting in the creation of 6,190 jobs for London. Think London therefore plays a crucial role as a promoter of London as a business destination for inward investors, both marketing London's benefits to an international audience, advising and consulting with investors to help them setup in London successfully, and acting as mediator between potential investors and the city government.

2.6 Summary

The literature review outlined the research context for this thesis, informed by a review of relevant academic work, focusing on the following seven thematic areas (summarised again in Figure 9): economic geography; globalisation; competitiveness; business decision-making; and specifically for the context of London, the thesis case study, London's polycentric business landscape,; FDI into London; and the policy context of FDI promotion.

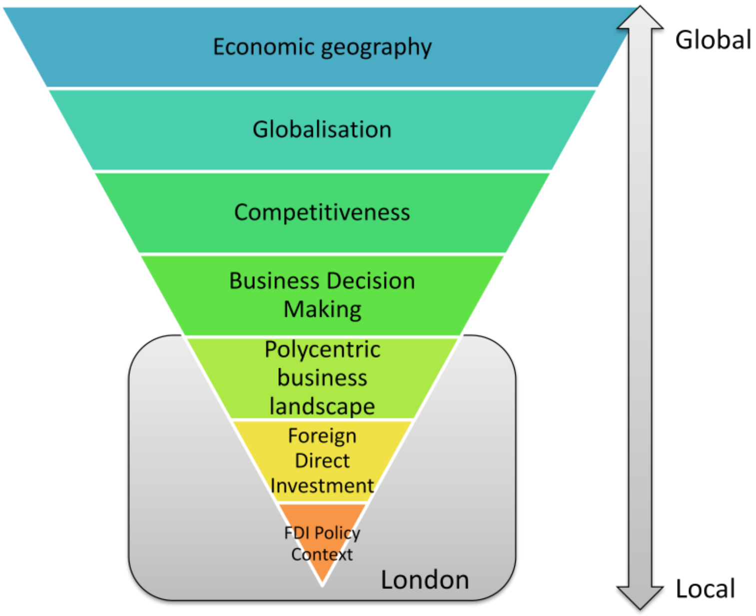


Figure 9 : The seven components of the literature review

The first part of the literature review gives an overview of the development of economic geography over the past 200 years, investigating spatial allocation and the resulting economic integration of regions through comparative advantages, such as external economies of scale (Marshall 1890), and industrial linkages through co-location between firms. Secondly, the emergence of the "New Economic Geography" (Krugman 1991) enables the integration into a coherent framework of centripetal (agglomerating) forces, such as labour market pooling, technological spillovers, concentration of suppliers, and market size and centrifugal (dispersion) forces related to immobility of labour, increases in land rent, and external diseconomies of scale. NEG allows a spatial view on international trade and the growth of foreign direct investment, more generally known as globalisation, linking economic agglomeration theory, globalisation, and the rise of FDI as a predominant force of economic development.

How do these global political, economic, and social changes affect the spatial development and role of cities? The death of distance, far from diminishing the role of cities, has given rise to a new network of world cities as the dominant force organising global economic activities. Importantly, in a globalising economy, cities and regions compete for the attraction of local, domestic, and foreign economic investment, with FDI determining to a large part the competitiveness of world cities such as London.

This literature review moved on to investigate conditions needed to attract and retain investment from both domestic and foreign firms, providing a review of some of the recent competitiveness frameworks for general economic investment that have emerged to explain why some nations, regions, or cities in the new globalised economy are more successful than others. One of the most influential theories was developed by Porter (2003), who argues that the strength of regional economies is strongly correlated to the strength of local clusters. Such clusters are composed of co-locating competitors and suppliers tapping into an established ecosystem of specialist suppliers of goods and services, along with a pool of appropriately skilled employees, enabling local 'knowledge spillover' between competing firms. Other authors (Kitson et al. 2004; Florida 2003) criticise Porter's work as being too focused on clusters, and argue for the importance of local knowledge, and creative and social capital as supplementary externalities that are of critical importance to regional performance. Leading on from general competitiveness, specific location variables are investigated which affect and guide inward investment into specific places. As summarised in Figure 5, the review found that at the inter-city and intra-city levels, agglomeration benefits both weak and strong are seen as attractive to FDI. This research then informs and guides the understanding of the relative importance of different location characteristics, at different spatial scales, which will guide the development of the case study SDSS.

Apart from the rational empirical investigation of business location variables, evidence is also collected regarding the impacts of imperfect or irrational decision-making, which are linked to the cognitive and psychological factors influencing human decision actors. The same constraints noted for general organisational decision-making apply to FDI decision makers who will expose specific compounding limits such as unfamiliarity with London's dynamic and heterogeneous business landscape, as well as the importance of the location decision for establishing a successful presence in London. These limitations can be addressed using a SDSS aimed at helping the business location decision-making process.

The second part of the literature review develops a better understanding of the geographic, economic, and political context of this study involving Greater London, the UK's only world city with 7.51 million inhabitants, equivalent to about 15 % of England's population. London hosts some of the key financial markets, headquarters of over 100 large companies, important clusters of business services companies such as law firms', accountancy and consultancy businesses, as well as clusters of creative and life sciences industries (Think London 2006a). This understanding of the city as a whole and its role in the world economy is expanded to examine the economic landscape of London, specifically its diverse and polycentric business neighbourhoods. The distribution of economic activities, and specifically the role and importance of clusters for different sectors of London's economy, is explored through a review of studies of the creative, financial, and business services sectors, exposing the benefits and attraction that these clusters offer to potential external investors. These clusters are also a powerful expression of the polycentric nature of London.

Given the dependence of London's economic competitiveness on the continued attraction and retention of FDI, a review of the policy context of local government FDI promotion activities in Greater London is also presented. The importance of FDI as a driver of London's continued economic success is evident in the support local government and the private sector extends to investors, specifically through its official inward investment promotion agency, Think London.

2.7 Conclusion

This literature review contains a general overview of several topics of interest to inform the research goals of this thesis, which in turn structure and are applied to the development of a spatial decision support system to assist foreign direct investment location decision-making. As a reminder, the research goals of this thesis are:

1. To understand London's diverse and polycentric business environments:
    a. Identify relevant business location decision-making factors according to the literature review.
    b. Discover a coherent, consistent, and relevant geographical framework modelling London's business neighbourhoods, by which to integrate disparate spatial datasets representing identified business location variables, and

   c. Implement a geo-business classification of London neighbourhoods describing and distinguishing areas based on multifaceted business environment characterisations.
2. To formalise business location decision-making, qualifying and quantifying location preferences according to investor needs:
   a. Evaluate and implement an appropriate decision-making methodology to capture and analyse firms business location decision-making preferences,
   b. Develop a computational model integrating location preferences with the geo-business classification of London neighbourhoods, ranking and generating location recommendations.
3. Support business site decision-making through an integrated prototype system:
   a. Implement a dynamic and rich user interface for the system, guiding and supporting the user through the location decision-making process according to the model developed, allowing the geo-visualisation and exploration of location recommendations.

Research objective 1a, identifying a framework for business location decision-making, was addressed in this literature review through the investigation of the complex nature of the drivers of business location choice. The processes and variables involved in characterising location choice were identified through the review of agglomeration and competitiveness frameworks, as well as empirical research in FDI location decision-making at the intra-urban spatial level. This knowledge on relevant characteristics deemed attractive to investors at the intra-urban scale forms the starting point for the development of a spatial location variables framework, crucial in the classification and characterisation of a set of business neighbourhoods.

The literature review focused in the second part on the specific case study area of London. This section addresses not only the general current nature of Greater London's economic development, but also highlights the diverse and polycentric business neighbourhoods, which form London's geo-business landscape, characterised by the clustering of industry sectors in specific neighbourhoods. The characterisation of the spatial structure of London's economy informs **research objective 1b & 1c**, i.e., the development of a relevant geographic framework of London's neighbourhoods detailed in Chapter 5 – "Spatial database", and Chapter 6 – "Geo-business classification for London".

Research goal 2a & 2b, the development of a relevant decision-making process applied to FDI business location choice, depends not only on knowledge of the relevant location variables involved in the decision-making process, already addressed, but also on knowledge of organisational decision-making processes. The literature review enables an understanding of the decision-making and, specifically, the inherent limitations of rational decision-making by managers involved in location choice, compounded by FDI-specific limitations such as unfamiliarity with London. These limitations also justify the need for a Spatial Decision Support System supporting investors in their location choice to support and guide inward investors through the location decision-making process. The need for a decision support methodology will be further expanded in Chapter 4 – “Research framework”. The specific choice of a computational method for the combination and generation of location recommendations is detailed in Chapter 7 – “Multi-Criteria Decision-Making model base”.

The literature review did not touch directly on **research goal 3**, the development of an integrated prototype system, which relies on the prior development of a set of building blocks such as the spatial database of geo-business neighbourhoods, or the computational decision-making model. Chapter 8 addresses the specific implementation of this prototype system.

3 Evidence base for business site selection

This chapter is concerned with the discovery of a sound evidence base from which to develop a data framework of FDI-relevant location variables. The analysis of existing work from investor surveys, competitiveness frameworks, and other reports enables the review and identification of relevant benchmark variables characterising competitive urban environments. Supplementary evidence is presented through city branding exercises, such as Anholt's city brands (2006), with a focus on specific cities and their "city brand."

Although these market research projects provide an overview of relevant factors influencing the FDI investment attractiveness of different world cities and/or regions, this chapter also includes specifically targeted primary research undertaken for the case study area of London. A set of interviews with FDI promotion experts from Think London presents another rich source of location variables relevant to FDI investors considering London. The combination of primary and secondary evidence informs the development of a unified data framework for business location decision-making. The second part of this chapter presents an empirical analysis of historic FDI investment patterns, focusing on a better understanding of the complex nature and functional scale of London's business landscape, investigating the clustering behaviour of investors from different sectors, functions or countries of origin.

Taking into account the evidence gathered on both the differential firm decision-making and spatial scales of business location decision-making, the work presented here enables the development of a structured and parsimonious spatial data framework. This framework enables the development of a generic model of the urban environment, able to capture and characterise London's diverse business neighbourhoods, relevant to different business sectors, functions, or countries of origin.

3.1 Business location decision-making in cities

Aided by technological, economic, and cultural advances previously labelled as globalisation, today's corporations can coordinate many functions across multiple locations. For example, manufacturing locates where cheap labour and abundant resources make production cost-effective, back offices locate in smaller cities with an educated labour force, reduced labour and real estate costs, and management locates in a global centre with excellent transport links and attractive lifestyle amenities (Cohen 2000).

The literature review presented in the previous chapter provides a summarised understanding of the relative importance of different location characteristics, at different spatial scales, useful in the context of the development of a spatial database of FDI-relevant location variables. The review of drivers of location choice is further developed in this chapter to give a more detailed empirical understanding of relevant location variables influencing city competitiveness. The drivers of business location decision processes, how these location decisions are reached in businesses, and what factors influence business location decisions are explored to further the understanding of what drives city competitiveness. This review is specifically targeted at business location decision-making at the intra-urban scale of a city's constituent neighbourhoods.

3.1.1 Drivers of location choice: Brand Cities

City competitiveness has emerged as a driver of regional development policies, driving and contributing to a 'Constructed Advantage' (Philip Cooke & Leydesdorff 2006) by creating or encouraging a favourable business environment that encompasses local economic conditions, governance, knowledge infrastructure, community, and culture. For example, in the US, the re-invention of urban centres as vigorous, vibrant foci of the new knowledge economy, and hence desirable places to work and live, has become a major driver of regional development policy.

In this intensely competitive environment, the desire of regions, cities, and specific city neighbourhoods to develop and project an appropriate identity or 'brand' remains a topic of debate and some controversy (Kavaratzis & Ashworth 2005). Embracing the concept of city competitiveness, and promoting the value of developing an image or brand of the city that allows the characterisation, promotion, and marketing of a given urban area as a 'product'[18], 'City Brands' such as Anholt's (2006) produce rankings of major cities are based upon regular global surveys. Anholt's surveys attempt to capture attitudes towards cities that combine both economic and quality of life issues, with the most recent survey grouping these factors into six components, detailed below, which combine to give an overall score for a city.

[18] Business Improvement District(s) (BID) are another example of targeted marketing of specific areas as a product. They emerged as a public-private partnership in a given urban area (neighbourhood) financed by a supplemental levy on local businesses. These BIDs aim to develop a common identity and marketing strategy aimed at making the area attractive to visitors and businesses. For example, five BIDs are part of a pilot project by the London Development Agency in 2003, expanding to 20 operational BIDs in 2009 (LDA 2009). See also section 5.2.1 of this thesis.

- **The presence** – perceptions of the city's international status and standing.
- **The place** – physical aspects of each city, including perceptions of the quality of the environment, transport infrastructure, and factors such as climate.
- **The potential** - the economic and educational opportunities that a city is believed to offer visitors, businesses, and immigrants.
- **The pulse** – how exciting people think the city is, and how easy they think it would be to find interesting things to do there.
- **The people** – are citizens perceived to be warm and friendly, or cold and prejudiced against outsiders? Would it be easy to find and fit into a community that shares their language and culture?
- **The prerequisites** - the basic qualities of the city. What is it like to live there? How easy would it be to find satisfactory, affordable accommodation? What is the general standard of public amenities?

When the results of such surveys favour a particular location, they are rapidly incorporated into the marketing message of high-ranking cities. These rankings and associated marketing messages about cities' attractiveness to different businesses prove useful for marketing purposes at a high-level positioning of a city.

A number of ongoing studies and surveys confirm the relative importance of such factors as drivers of foreign direct investment in different industrial sectors. A useful framework is provided in KPMG's Competitive Alternatives Report (KPMG 2008). Although this report primarily focuses on the economic factors that differentiate locations (as shown in the upper-left quadrant of Table 5), it also notes the importance of 'softer' business and personal factors that strongly influence location choice.

Table 5: Drivers of FDI investment[19]

	Cost Factors	Other Key Factors
Business	• Land/building/office • Labour wage/salary/benefits • Transportation and distribution • Utilities • Financing • Federal/regional/local taxes	• Business environment • Labour availability and skills • Access to markets, customers, and suppliers • Road, rail, port, airport infrastructure • Utility and telecom/internet service reliability • Suitable land sites • Regulatory environment
Personal	• Personal taxes • Cost of housing • Cost of consumer products and services • Health care costs • Education costs	• Quality of life • Crime rates • Health care facilities • Schools and universities • Climate • Culture and recreation

The significance of non-economic factors in driving location choices is reinforced in responses to a qualitative survey conducted by Think London (2006). The telephone survey polled 219 foreign-owned companies with offices in London who were asked to indicate the *'Most important factor that influenced their decision to locate in London'*, with the results of this survey summarised in Table 6.

[19] Adapted from KPMG Competitive Alternatives Report (2008)

Table 6: Results of FDI survey on location variables[20]

Most important factor influencing location decision	
Status as a global business city	29%
Client base proximity	17%
Other companies in sector	16%
No main factor	8%
English language	7%
Access to European markets	6%
Ease of international travel/global position	3%
Quality of life	3%
Availability of skilled labour force	2%
Access to other markets	2%

This survey also included 15 face-to-face interviews with senior executives within foreign firms to gain a more detailed understanding of their views of London, with the following main outcomes:

London's position as a gateway city to the rest of Europe, and its status as a global business city, are the most important location factors according to the survey. Access to markets, as well as accessibility to the rest of the world, are indeed important facets of London as evidenced in this quote:

> *"The central hub of Europe is London and London is a launch pad into Europe."*

Survey results also support the fact that companies locating in London are strongly influenced by aspects of access and co-location with clients, competitors, and/or partners, evidenced in the wider telephone survey, and expressed by the following quote:

> *"London is a 'virtuous circle' – many companies have an HQ in London, so to access them, other companies feel that they need a London HQ, and so on."*

[20] Adapted from Think London (2006c)

Softer, less tangible, aspects associated with London's status as a 'World City' are also clearly important, as well as the cosmopolitan feel of the city and its diverse population:

> *"London has great access to language skills (due to mix of nationalities). Used to have multi-lingual helpdesk in Amsterdam, but had problems finding appropriate language skills – moved to London and was pleasantly surprised how easy they were to find, and good ones"*

3.1.2 Differential location decision-making

Whilst these survey results offer a qualification of a diverse set of high-level city competitiveness variables, they offer little insight into specific factors that influence the intra-urban location decisions of specific companies taking into account different functions, sectors, or markets. In a review of industry surveys on business location decision-making, Cohen (2000) notes that there are four fundamental components of business activities that influence where a company might locate all or parts of its activities:

- business *sector*,
- business *function*,
- product *maturity,* and
- business *culture*.

The business sector in which a company operates has a strong influence on the location factors that influence its location choices. Classic manufacturing businesses, for example, will weigh the transport costs to market against transport costs for raw materials, whereas retail sector businesses will want to maximise sales potential and locate as close as possible to their potential customer base (Laulajainen & Stafford 1995). Along with industry sector differences between companies, there is an increasing flexibility by firms to geographically separate business functions inside a company, creating divisions of labour between major cities nationally, and in the case of FDI, internationally, since companies now recognize differential location needs of different business functions. This increasingly results in a geographical separation between head office, back office, research and development, and manufacturing functions, with a clear impact on the competitiveness of cities looking to attract these various functions. Relevant location variables for different functions are listed in Table 7, and can be summarised as follows:

- Corporate headquarters are preferentially located in cities with excellent domestic and international transportation links (Button & Stough 1998) to enable efficient face-to-face meetings with various clients, partners, suppliers, as well as an abundance of high quality professional business support services, and a high quality of life.
- Research and Development functions also need a highly educated and innovative workforce. These conditions can often be found in metropolitan areas with large universities (Cohen 2000).
- Back offices tend to be in places with good telecommunication links and affordable living costs, with a qualified labour force.
- Manufacturing, as already noted when looking at companies' locations as a whole, can be physically separated from other functions, located to satisfy needs specific to the manufacturing process, including access to materials, labour, and/or low transport costs.

Table 7: Location decision-making variables by function[21]

Function	Location Preferences	Cost Sensitivity
Headquarters	• Accessible to international airports • High-end hotels, restaurants, entertainment, and culture • Access to professional services • Office space availability • Diverse professional workforce • High-end residential housing for managers and affordable housing for support staff	Less important than availability of key requirements
R&D	• Access to universities • Highly educated workforce • High quality urban environment likely to attract educated workforce	Less important than availability of talent
Back Office	• Telecommunication facilities • Affordable housing • Workforce with technical skills • Good schools • Adult education facilities	Sensitive to costs: real estate, telecommunications, housing, and taxes
Manufacturing & Distribution	• Good infrastructures: transport and utilities • Workforce with specialised skills	Sensitive to housing costs, taxes, and utilities

[21] Adapted from Cohen (2000).

The product maturity of companies also matters, with a distinction between “young” companies in the new media, internet, and technology sectors who are developing new products and are less sensitive to real estate costs while looking for sophisticated labour markets and talents. In comparison, cost factors come to the forefront for companies with mature products, where production costs are most important.

Through phone interviews with business site location experts, Cohen also identified business culture as an important factor influencing business location decision-making. For example, software companies tend to look for existing clusters, as they want to interact with companies similar to them, whereas pharmaceutical companies seek confidentiality and gravitate to locations that are more isolated. Florida (2003) also makes the point that the perceived quality of urban areas and resident population can attract companies with a matching corporate culture. For example, the cultural and creative-led regeneration in Hoxton on the fringes of the city of London has resulted in the creation of a vibrant and edgy neighbourhood (Pratt 2009). This neighbourhood is perceived by creative sector companies to be a good cultural fit with their corporate culture, and thus an attractive business location.

3.1.3 Inward investment promotion - interviews

The review of third party surveys and research summarized in the previous section presents a set of business location variables, along with an understanding of how sector, function, and/or corporate culture also influence the decision-making process and location variables considered by firms.

In order to develop a set of specific data needs for this research thesis, the experience provided by the collaboration between Think London and UCL proved invaluable. In the context of the development of the GIS capability of Think London, first-hand evidence was gathered from its staff, which are all experts in foreign direct investment promotion and have detailed knowledge of past FDI location decisions and current needs. A set of face-to-face interviews with these FDI experts enabled the collection of valuable intelligence on FDI-relevant location variables. The interviews captured the data needs for a wide selection of potential users, from different industry sectors, looking to set up different functions (e.g. headquarters, R&D, manufacturing) in London, and coming from different origin countries. The survey data collection was based around loosely structured interviews, with a set of prepared questions guiding the interview and covering all the aspects of both functional and data requirements needed for the development of the user requirements. In summary, the interviewees felt it important to be able to demonstrate to their clients the following location factors:

- Infrastructure, services, and facilities
  - Transport infrastructure (airports, roads, train stations, ports)
  - Accessibility by public transport, logistics
  - Communication hubs
  - Environmental facilities
  - Schools, hospitals, universities, R & D centres
- Property
  - Commercial property offer and development potential
  - Residential property offer
- Population and workforce
  - Characteristics (demographic groups, educational status)
  - Quality of urban environment
- Businesses
  - Industry clusters and associations
  - Retail and tourism hubs
- Regulatory and policy
  - Rules and regulations
  - Development opportunities

The detailed results of the data requirements gathered from the user interviews are presented in Appendix 11.1 – "FDI location decision making requirements". These results, together with the evidence presented in previous section and literature review then form the knowledge base for the development of a data framework relevant to business location decision-making.

3.1.4 Towards a structured data framework

The combination of secondary and primary evidence as previously presented informs the development of a unified data framework for business location decision-making. In the context of the specific case study of FDI promotion into London, this unified data framework forms the basis for a generic model of the urban environment, able to capture and characterise London's diverse business neighbourhoods, to support investors from different sectors, functions, and/or origins. The data framework will guide the development of the database component characterising location alternatives in London as part of the decision-making process modelled in the SDSS. It is composed of five major themes of neighbourhood characteristics potentially relevant to different businesses' individual location preferences:

1. the discovery, quantification, and qualification of industry sector clusters **(*Companies*);**
2. the characterisation of the available talent pool and daytime population **(*Working Population*)**;
3. quantity and quality of the ***Property Stock***;
4. a more general appreciation of the ***Living Environment*** of London neighbourhoods;

and finally ***Accessibility*** to different London neighbourhoods through public transport. In the context of the characterisation of industry clusters, this data framework does not aim to model and support the highly individual and potentially complex co-location preferences of individual firms, including a firm's attraction, defined as co-location with potential suppliers, partners, customers, or repulsion, the desire to be located away from competitors. Such individual location preferences are not easily modelled in this proposed generic data framework of London's business landscape, and thus are considered outside the scope of this thesis.

The implementation of this data framework in the context of the development of the spatial database component is detailed in Chapter 5 – "Spatial Database".

3.2 Exploratory analysis of FDI

The development of a location data framework has thus far been driven by a review of relevant literature on agglomeration benefits, competitiveness frameworks, and specific surveys eliciting location factors affecting business location decision-making. This knowledge was supplemented by interviews with FDI experts in the specific case study area of London. The information on business location decision-making gathered through this work clearly goes a long way towards developing a data framework relevant to business location.

However, there is a need to develop a better understanding of the general economic landscape of London through empirical studies of FDI investment patterns. The literature review presented some evidence from other authors on specific clusters, for example in the media or financial services sectors in Central London (see section 2.5.1), but this needs to be expanded to a more general study of FDI investment patterns across London. This work develops an empirical study of historic FDI patterns, gaining an overview of the complex FDI business landscape of London. The analysis presented here also addresses questions surrounding the effects of co-location benefits among partners, competitors, and suppliers of companies in a specific sector, function, or even provenance. Either these differences can be conceptualised, as a tendency to agglomeration of activity, or dispersion of activities, be it of similar or dissimilar activities. Apart from the presence and nature of such co-location effects, the spatial scale at which firms make location decisions and the resulting scale and structure of London's business landscape will inform the development of a relevant spatial framework for location decision-making.

Apart from the discovery of the general structure and scale of economic activities across London, the investigation of co-location is also relevant, meriting further investigation as one of the most important factors influencing business location decision-making. A specific question to be answered through this analysis is whether the investment patterns of different types of inward investors vary significantly. Such departures from the overall distribution could indicate that FDI location choices follow a slightly different set of rules and variables than the locating of general offices, factories, shops, and other business activities by indigenous companies. If this is the case, then these differences will need to be accounted for in the decision-making process across different types of companies.

3.2.1 Overview of economic activity patterns

The general spatial structure of London economic activities can be visualised by generating measures of density of workplaces or employment across the city. A good data source for such a general overview of the spatial distribution of economic activities is the Annual Business Inquiry (see section 5.1.1 – "Companies" for details on this dataset), which enables the analysis of overall employment numbers, as well as counts of workplaces per Lower Super Output Area (LSOAs). The maps presented here are Gaussian Smoothed Kernel surface[22] (GSK) depictions of employment and workplace counts aggregated to LSOAs (the lowest published geography). As such, these interpolations of counts represent some fallacies, specifically as Output Areas were generated according to resident population counts, and thus outside of densely populated areas might become much bigger, even though there is significant employment in such areas. This needs to be taken into account when visually inspecting these maps.

[22] Gaussian Smoothed Kernel (GSK) is interpolation method, creating a continuous (or prediction) surface from sampled point values. In this case, numeric values (number of jobs or workplaces) observed at a set of irregular locations (LSOA centroids) are redistributed to predict expected frequency (number of jobs or workplaces) for each surface raster cell.
Kernel Density Estimation (KDE) calculates the density of points in a search radius around those features, according to a kernel distance decay function. In this case, this gives a surface where each raster cell is a measure of the density of points, in this case, number of FDI investors per cell.

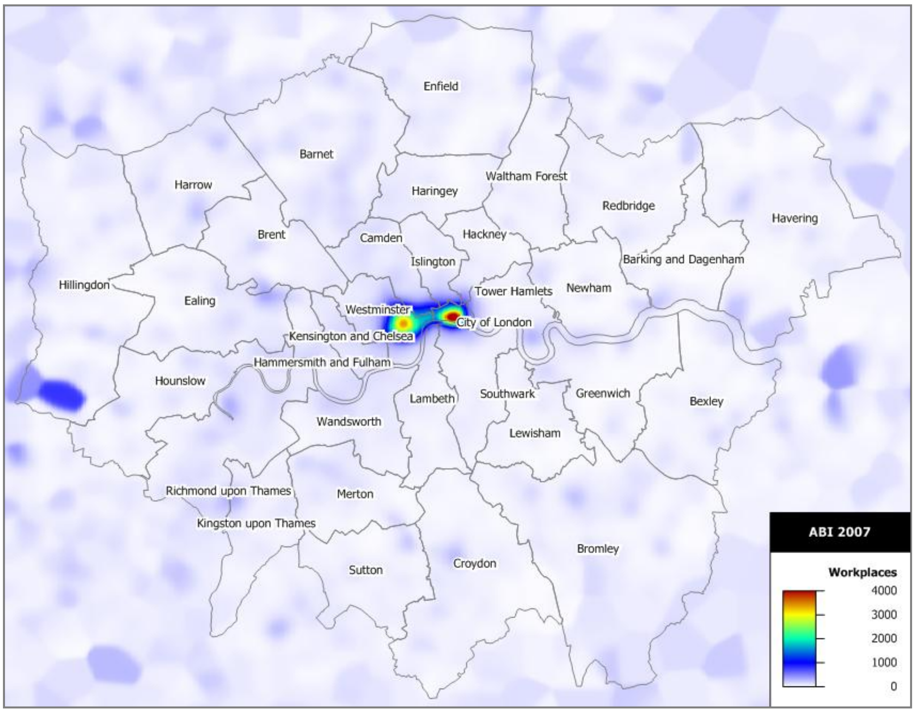


Figure 10: Workplaces concentration of Greater London

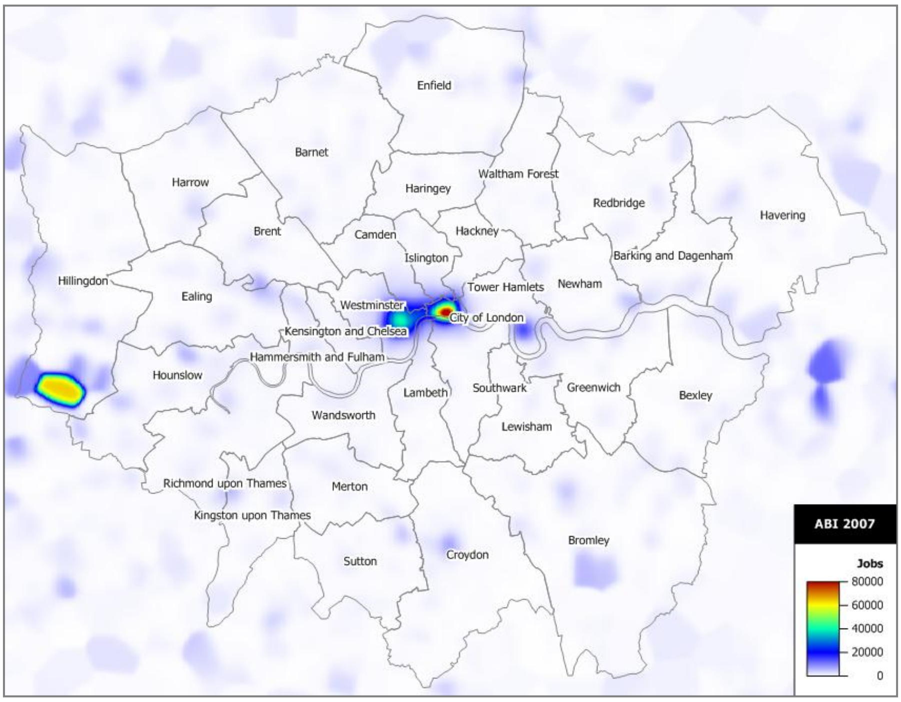


Figure 11: Jobs concentration of Greater London

These maps (see Figure 10 and Figure 11) illustrate the spatial distribution of both counts of workplaces and counts of equivalent full-time jobs, and highlight the uneven spatial distribution of both workplaces and jobs across the 32 Greater London Boroughs and the City of London. The majority of economic activity is concentrated in Central London, from the West End and Soho to the City of London, the centre of financial services. Canary Wharf is more clearly visible in the jobs surface than the workplace surface, indicating a relatively small number of very large employers. In addition, the maps reveal Heathrow Airport in West London as a major provider of employment. Given the spatial smoothing of the interpolation algorithm, smaller secondary centres of activity are less visible, but none the less present. These secondary centres can be related to smaller urban and suburban town centres outside of the main Central Business District of Central London or Canary Wharf.

3.2.2 FDI patterns of investment

Focusing on the FDI patterns of location, the goal of the analysis is to describe and characterise the spatial distribution of FDI investments into London, and more specifically, to investigate differences in the spatial concentration, or clustering, between investors according to their sector, function, and originating country. Spatial clustering of certain communities, activities, or functions would imply that the firms draw some co-location benefits from this agglomeration.

As part of its mission, UK Trade and Investment[23] (UKTI) records and collects information on all foreign investments into the UK. For the period of 2006-2007, UKTI provided records of investments for the London region to this research project. This dataset records investments, including mergers and acquisitions, along with the number of jobs created or safeguarded, as well as investors' details such as geographic provenance, industry sector, and function. Company records are geocoded to the postcode level for 735 firms in the London area and wider South-East. An overview map of the spatial distribution of the total dataset can be seen in Figure 12.

[23] UK Trade and Investment (UKTI) is a UK Government organisation, which supports UK-based businesses in international markets and promotes and supports inbound FDI to the UK.

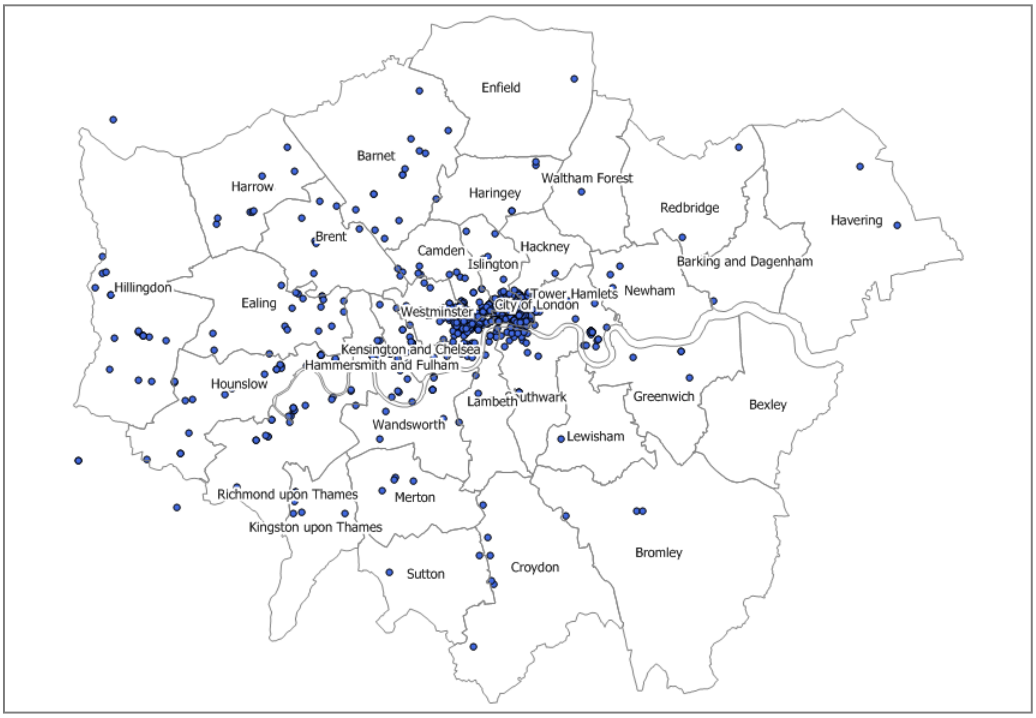


Figure 12: FDI business locations in Greater London.

The distribution of FDI across London for the financial years of 2006 and 2007 can be mapped in a similar fashion to the general levels of economic activities presented before. As the dataset does not have any reliable counts of the size (e.g. number of jobs) for each investment, the analysis only investigates the density of co-location of points, disregarding the size of individual firms. Kernel Density Estimation (KDE) allows the estimation of the density of point patterns, allowing for a visualisation of patterns of concentration of activities in Figure 13. The bandwidth for the KDE estimation (in this case 1 kilometre) is chosen to represent the spatial scale of town centres across London. A good example of this can be seen in the zoomed-in view of Central London (see Figure 14), representing the point pattern along with the resulting KDE surface.

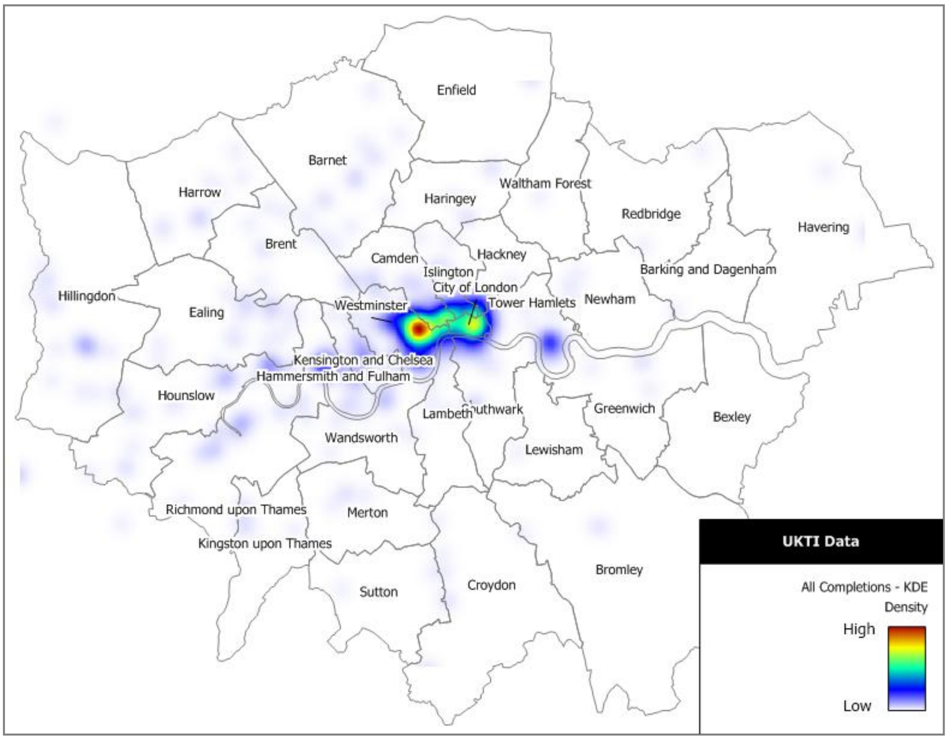


Figure 13: Jobs concentration of Greater London

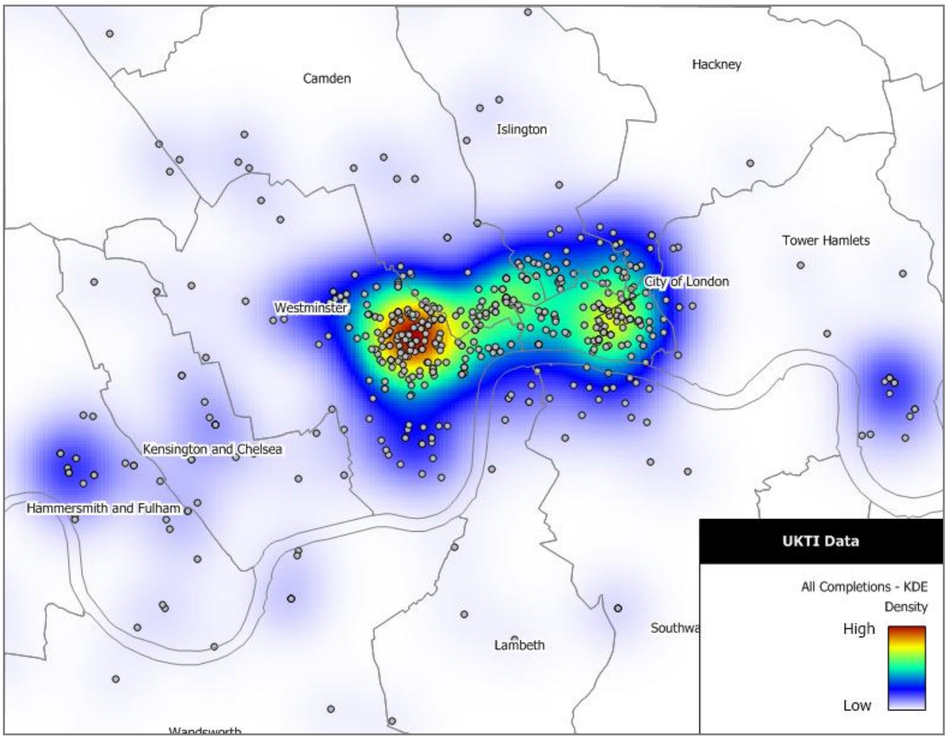


Figure 14: FDI location concentration in Central London

Comparing between the map of general economic activity levels and the map of FDI investment concentrations offers no significant differences from the visual inspection of these two surfaces. Most FDI investments still focus on Central London business areas such as the City and the West End, with secondary centres of investment in Canary Wharf and West London, including Hammersmith, which can be attributed to general urban agglomeration economies. The question then is, if the spatial structure of FDI investments presents patterns of concentration above and beyond purely urban agglomeration economies, attributable to industry sector, function or provenance clustering effects? The following section presents a review of relevant spatial measures of such effects, and the methodology used in the work for the qualification of the clustering of FDI investments.

3.2.2.1 Methodology

Economists have traditionally used concentration indices to determine whether there is agglomeration or dispersion of firms in a given territory (Marcon & Puech 2003), such as the Gini index and the *G* index, proposed by Ellison & Glaesner (1997), which also incorporates the size of firms. Marcon & Puech (2003; 2006; 2007) note that for these measures, any evidence for spatial clustering is only valid for a specific spatial scale, and indeed can be an effect of the Modifiable Aeral Unit Problem[24] (MAUP). Nearest neighbour distance-based measures such as Ripley's K and the derived Besag's L function look at inter-point distances without relying on the aggregation to areal units, thus circumventing the MAUP that plagues the Gini or G indices. Marcon and Puech recognised the limitations of Ripley's K and Besag's L function[25] and developed their own function M. According to Marcon & Puech (2007), the M function allows for the comparison of an economic sector to the aggregate activity (represented by all sectors), as a cumulative function counting neighbours of points up to a given distance $\boldsymbol{r}$.

[24] Modifiable Areal Unit Problem (MAUP): A problem arising from the imposition of artificial units of spatial reporting on continuous geographic phenomena resulting in the generation of artificial spatial patterns.

[25] Distance-based measures such as Ripley's K and Besag's L function analyse concentration or dispersion by counting each firm's average number of neighbours within a circle of a given radius. The actual number of firms is then compared against the expected equivalent according to a spatial randomness process. Ripley's K thus represents a measure of excess localisation or dispersion, which can be attributed to, for example, economies of scale, sector internal co-localisation economies, and general urbanisation economies. The assumption, and drawback, lying below the Ripley's K and Besag's L functions is the hypothesis of a constant density (i.e., a homogeneous distribution) of economic activity. A more realistic assumption is that the underlying distribution is heterogeneous, for example, lakes and mountains where firms cannot locate. The same can be said of spatial patterns resulting from urbanisation economies (e.g., the benefits of concentration of activities in Central London versus surrounding areas and suburban neighbourhoods.)

The M function takes as the starting point *Plants* (economic activities) which are located as points on a map. A reference point type (e.g. Sector, origin) is selected and a target neighbour type called $\boldsymbol{T}$ is defined: other companies either from the same type (intra-industrial) or of a different type (inter-industrial). The average number of target neighbours is compared to a benchmark to detect whether they are more or less frequent than if plants were distributed randomly and independently from each other. To control for variations of local density of points, each number of target neighbours ($\boldsymbol{T_i}$ around a point $\boldsymbol{i}$) is normalized by the number of all neighbours in the same area ($\boldsymbol{N_i}$). For each reference point, a ratio of target neighbours is generated ($\boldsymbol{T_i/N_i}$) within the distance r from each point $\boldsymbol{i}$. The average of this ratio is computed to the global ratio calculated from the entire territory. The *M* function is normally expressed as a ratio for convenience as the benchmark is equal to one:

$$M = \frac{T_i/N_i}{T/N}$$

The M function as a distance-based method controls for local variations of plant/office/firm density by normalising for each target neighbour against the total number of neighbours in the same area. The M function is normally computed for a set of distances (r_{min} to r_{max}) and presented as a continuous function on a graph, including confidence intervals for the null hypothesis of independence of plant locations.

The M function allows the investigator to analyse, on a global scale, any evidence of excess spatial concentration. The measure does not presume the presence of an underlying homogeneous spatial distribution to investigate the spatial distribution, a big advantage over previous methods, such as the K function, and appropriate to investigate the inhomogeneous spatial distribution of economic activities across London. Secondly, the M function can be run iteratively for a set of distances, and thus can map patterns of concentration or dispersion across multiple spatial scales, negating any MAUP.

In the case of an investigation of FDI into London, the analysis first determines if there is any clustering behaviour of FDI-type businesses, above and beyond the heterogeneous structure of the underlying general economic activity patterns presented previously. Secondly, the analysis can ascertain at what spatial scale clustering of FDI activities occurs, from the street or block level to the neighbourhood and subregional scale.

3.2.2.2 Analysis

The benchmark against which the M function compares the different FDI investor's classes was the general spatial distribution of FDI investment (753 records). The computation was done for three variables - Country of Origin, Sector, and Function - according to the classifications contained within the UKTI dataset. The analysis of the M function results highlights particular tendencies for either agglomeration or clustering of activities over and above what would be expected from general FDI investors, or inversely dispersion of activities beyond the expected average.

The M function algorithm[26] generates confidence levels obtained through Monte Carlo Simulations. For the purposes of this study, the M function was generated up to 15 kilometres distance, in 500-metre steps. This is believed to represent a compromise between computation time and a relevant spatial resolution of the curves to highlight patterns of excess agglomeration from the local neighbourhood up to the spatial scale of London regions. Confidence levels of five percent were generated by the software to identify any significant departures from Complete Spatial Randomness (CSR) of the process.

It is important to note that the M function only provides a descriptive analysis of intra- and inter-industrial geographies, and can thus not provide any mechanistic explanations for the patterns of agglomeration or dispersion that the M function observes.

3.2.3 Discussion

The detailed results of the M function analysis for the different variables can be found in Appendix 11.2 – "M function Analysis". The main findings from running the M function, regarding differences between industry sectors, functions and investors' country of provenance, as well as the spatial scale at which such effects appear, are discussed in this section.

There was evidence of excess concentration in all three classifications. Some origin countries, including the US, India, Canada, Italy, and Korea, presented excess concentration, although for some of these countries, the sample was quite small. There were also some industry sectors such as financial services, creative industries and ICT, tourism and leisure, and life sciences, as well as some other sectors with very small samples, which presented evidence of concentration. Some of these sectors were previously investigated in cluster studies, for

[26] Available at http://e.marcon.free.fr/Ripley/cadre.fre.htm

example financial services in the City of London, or the creative industries cluster in Soho or Hoxton. Headquarters were spatially concentrated, which could be explained by the preference for high value and prestigious office space in the best sites in Central London. R&D showed strong evidence of concentration, which could be explained by the co-location of research-intensive business activities with universities, for example. Distribution showed concentration as well. However, it should be noted that the analysis using the M function was hampered by the relatively small sample size of the dataset, once the sector, functional, or country classifications were applied.

An important conclusion to take from the analysis is the spatial scale at which clustering seems to happen. In most cases, the analysis highlighted the concentration to be highest at short distances of less than one kilometre. For the most part, significant concentration tapered off as the distance increased above a few kilometres. This informs the assumptions about the spatial scale at which economic activities locate and form clusters. In this case, they are observed at the scale of local neighbourhoods, areas such as local town centres or other local business, retail, or industry parks. This information guides the development of the geographic framework adopted in this study. As a result, the spatial scale of investigation for this study of the geography of London's business locations can be justified from these observations to be the local neighbourhoods and town centres level.

3.3 Conclusion

This chapter builds on the previously presented review of relevant academic research in the context of business location decision-making, along with a competitiveness and branding framework for cities and results of third party surveys, to build a more detailed understanding of how sector, function, or corporate culture influence the decision-making process and location variables considered by firms. Together with primary research into FDI-relevant location variables for London, this chapter develops a unified data framework for business location decision-making.

This data framework limits itself to the modelling of different urban business environments, applicable to a wide range of firms from different sectors, functions, or origins, capturing the following generic business location variables:

1. the discovery, quantification, and qualification of industry sector clusters (*Companies*),

2. the characterisation of the available talent pool and daytime population (*Working Population*),
3. the quantity and quality of the *Property Stock*,
4. a more general appreciation of the *Living Environment* of London neighbourhoods, and
5. accessibility through public transport of different neighbourhoods inside London.

It is important to note that the highly individual and potentially complex co-location preferences of individual firms are not supported by this data framework, owing to the focus of the development of a generic database relevant to a wide selection of different investors.

Apart from the development of a relevant data framework, the spatial nature and most relevant spatial scale of analysis and integration is also considered in this chapter. The empirical analysis of historic FDI investment patterns first enabled a more nuanced understanding of the complex nature of London's business landscape, and specifically of historic investment patterns. The most important conclusion from the analysis is evidence of the uneven nature of spatial economic development, highlighting the spatial scale at which firms agglomerate in London. London's local neighbourhoods (1-2km) are proven to be the dominant spatial scale at which FDI investors agglomerate. The spatial scale of investigation of business location decision-making in London which the data framework needs to take into account then can justified to be at the local neighbourhoods and town centres level. These results justify the need for a more relevant spatial subdivision for FDI promotion and location consultancy activities in London, other than the predominant subdivision of London into five subregions (see section 5.2 - "Geographic framework" for the development of the spatial framework). In conclusion, this chapter helped define the structure of a parsimonious data framework apt to capture and characterise London's diverse business neighbourhoods, enabling the design and implementation of a spatial database component.

4 Research framework

This chapter introduces the principal methodologies and processes used in this thesis, formalised and encapsulated in the research framework, guiding the further development of this research and implementation of the case study. The development of this research framework starts with an introduction and review of relevant Decision Support methodologies. Decision support system implementations have been driven mainly by advances in computing, resulting in the application not only to management problems, but increasingly to spatial problems as well. This has resulted in the emergence of Spatial Decision Support Systems (SDSS), integrating spatial data and processes into decision support. Through a discussion of relevant conceptual SDSS frameworks, the potential for efficient support of spatial decision problems such as business location decision-making is highlighted. Given this potential, this chapter is mainly concerned with the comparison and linkage of such a SDSS framework, including key definitions, characteristics, and concepts, with the previously stated research aims and objectives.

This evaluation enables the formulation of a research framework for this thesis, guiding not only the research into business location decision-making support, but also defining the salient characteristics of a SDSS for business location decision support. This chapter concludes with the application of this research framework to the specific case study of a FDI business location decision-making prototype. This work defines high level functional and data requirements for the effective provision of location decision support, as well as a relevant system structure guiding the system design. This discussion then leads to the implementation process of the proposed SDSS, discussed in subsequent chapters.

4.1 An introduction to Decision Support Systems

The academic formalisation of Decision Support Systems emerged in the 1970s, recognizing and formalizing developments in both applied organisational decision-making analysis and the advent of computer systems. The development and propagation of computers in University, Defence[27], Government and Company Research Departments in the 1960s enabled for the first

[27] Such as the SAGE (Semi-Automatic Ground Environment) air defence system for North America, developed in the 1960s. The ideas and technology behind SAGE went on to revolutionize air traffic

time the cost effective implementation of what was then coined Management Information Systems (MIS) for large companies (Power 2007). These MIS focused on providing managers with structured, periodic reports from accounting and transaction processing to support managerial decision-making. The development of interactive decision support was a natural evolution of the capabilities of a MIS, and included the development of data handling routines and analytical aides that encouraged a dialogue between the user and the system (Sprague & Watson 1993). A first generic definition of a Decision Support System then is (Sol et al. 1987, p.1) "a computer based system to aid decision-making."

Gorry & Scott-Morton (1971)[28] integrated earlier work on organisational decision-making (Simon 1960; Anthony 1965), acknowledging different types of decision structures and levels of managerial activity. They found that whereas MIS are most suitable to structured decisions, Decision Support Systems are relevant to semi-structured and ill-structured decisions (see Table 8 for a listing of different types of decisions).

Table 8: Classification of decision types[29]

Type of Decision	*Operational Control*	*Management Control*	*Strategic Planning*	*Support needed*
Structured	Inventory control	Load balancing production lines	Physical plant location	MIS, quantitative models
Semi-structured	Securities trading	Establishing marketing budgets for new products	Analysis of acquisition of capital assets	Decision Support Systems
Unstructured	Determining the cover photo for a monthly magazine	Hiring managerial personnel	R&D resources allocation	Human reasoning and intuition

A DSS is defined as a computer system that deals with ill-structured problems, i.e. a problem where at least some stage is semi-structured or un-structured. A DSS is composed of both a

control systems, both military and civil. SAGE enabled the US Air Force to collect, track, and assign interceptor jets to enemy bomber aircraft with only minimal operator involvement. The AN/FSQ-7, developed by IBM for the SAGE control centres, is the largest computer ever built, and will likely hold that record well into the future. Each machine used 55,000 vacuum tubes, about 2000 m² of floor space, weighed 275 tons, and used up to three megawatts of power.

[28] Scott-Morton in 1966 examined how computers and analytical models could support business planning, one of the earliest examples of a MIS incorporating elements of a decision support system.

[29] Adapted from Gorry and Scott-Morton (1971).

computer system that deals with the structured portion of a DSS problem, as well as the decision maker, who deals with the unstructured part of the decision problem, creating a human–machine, problem-solving system (Shim et al. 2002). This leads to an expanded definition of DSS as:

> *"an interactive computer-based system(s) which help(s) decision-makers utilise databases and models to solve ill-structured problems" (Sol et al. 1987, p.1)*

Sprague (1980) further distinguishes DSS from MIS , defining DSS as focusing on higher organisational or managerial decisions, aimed at top managers and executive decision makers, enabling user-centric control, flexibility, adaptability, and quick response, as well as support for decision-making styles of differing personnel, as opposed to MIS which focus on integration and planning of structured information flows and report generation. Finally, in order to be useful and relevant, Little (1970) defined a set of qualities a DSS had to possess: it had to be robust, easy to control and communicate with, and adaptive to its users, but still present complete and relevant detail.

4.1.1 Decision Support Systems Frameworks

Beyond the basic definition of the salient characteristics of DSS summarized in the previous section, there is a need to define the elementary structure and components of a DSS, formalised in a development framework, without which the system would not be able to interact and support the decision maker. Sprague & Watson (1993) offer a fundamental structure of elements or components needed for the development of a relevant and useful DSS, including (**1**) *data* representing the state of the real world; (**2**) *procedures,* the steps needed to solve the problem; (**3**) *goals* (evaluation criteria) and *constraints,* the desired results and limitations of the decision space; and (**4**) *strategies that* indicate which procedures to apply to achieve goals.

From a structured systems approach, the implementation of these elements then necessitates the development of the following components (Sprague 1980):

- **Specific DSS**: The hardware/software that actually accomplishes the work, e.g. the specific application with which the users interact and form their decision-making process.
- **DSS Generator**: A package of tools and software programs specifically adapted to enable users to generate from them a set of specific DSS implementations.

- **DSS Tools**: The foundational elements of hardware and software supporting the development of DSS. These include general-purpose programming languages and input-output devices used in a DSS.

In conclusion, according to Densham (1991), a Decision Support System framework needs to satisfy the following characteristics:

- an explicit design to solve ill-structured problems;
- powerful and easy-to-use user interfaces;
- ability to combine analytical models flexibly with data;
- ability to explore the solution space by building alternatives;
- capability of supporting a variety of decision-making styles; and
- allowing interactive and recursive problem solving.

These characteristics allow the definition of the most important functionality and capabilities of DSS, in the context of this research thesis. The following section takes into account the supplemental characteristics that Spatial Decision Support Systems have beyond DSS.

4.1.1.1 Spatial Decision Support Systems

In addition to the six generic characteristics of a DSS (Densham 1991) highlighted in the previous section, a Spatial Decision Support System needs to support further functionality, resulting from the inclusion of an explicit geographic component. In contrast to conventional DSS, SDSS not only require information on the criterion values, but also information on the geographical locations of alternatives. Analytical results thus not only depend on value judgements attached to the decision-making process, but also on the geographic locations of attributes and alternatives (Ascough et al. 2002). The special nature of spatial data and attached spatial processes necessitates the following supplemental conditions, which Densham expressed in his framework conditions:

- Input of spatial data into the system;
- Representation of spatial relations and structures;
- Spatial and geographical analysis techniques; and
- Output in a variety of formats including maps and graphs.

Together, these characteristics define the functionality required by any SDSS, and describe salient characteristics that differentiate such as system from, for example, a Geographical

Information System (GIS). A GIS is often defined as offering necessary functionality for the capture, storage, manipulation, analysis, and display of geographical data, and the idea that a GIS is suitable to support spatial decision-making is implicit (Densham 1991). However, Densham specifically identifies the lack of analytical modelling capabilities in GIS designed to support ill-structured problems, with most functionality geared towards the production of cartographic products. The main communication metaphor between the user and GIS are maps, along with tabular database reports, whereas a decision maker will likely need a richer and more flexible interaction with a SDSS, involving communication means such as reports, graphics, and charts that are specific to the expert domain. Finally, GIS are not designed to support diverse decision-making strategies adopted by different users. Individual judgments on variable weights and relationships, as well as the selective use of information to reach decisions, are not explicitly supported by GIS. Such judgements and analysis of potentially conflicting priorities is formalised in a structured approach for developing weights associated with different objectives or criteria, in terms of subjective importance to decision makers, with the overall score of one alternative outcome being the overall performance of the different criteria. This process has been formalised as Multi-Criteria Analysis methodologies (MCDM). The assumptions behind MCDM analysis then match and further specify the definition of DSS (Malczewski, 1999).

> *"The Multi-Criteria Decision Making Process assists stakeholders and decision makers in analysing the decision problem at hand, specifically for decisions which present trade-offs between different objectives, with no obvious optimal solution" (Reyck et al. 2005).*

From a structured system development perspective, the implementation of a SDSS then necessitates a set of fundamental components or building blocks that satisfy the following conditions: (1) a relevant **model (base)** enabling the capture and processing of decision makers' preferences into discrete decision alternatives, such as Multi Criteria Decision Making Methodologies; (2) a **spatial database** of location variables (Carver 1991; Jankowski 1995); (3) a graphical **user (base)** interface supporting decision makers through all the steps of the decision process and enabling a dynamic and interactive session (Malczewski 1999; Jankowski 1995); and (4) a **computation base** enabling the proper acquisition, storage, retrieval, manipulation, and analysis capability (Ascough et al. 2002). Therefore, a significant contribution of a SDSS is the integration of previously separate tool sets (data and model) through improved computation and user interfaces into a unified whole (see Figure 15) more valuable than the sum of its parts (Malczewski, 1999).

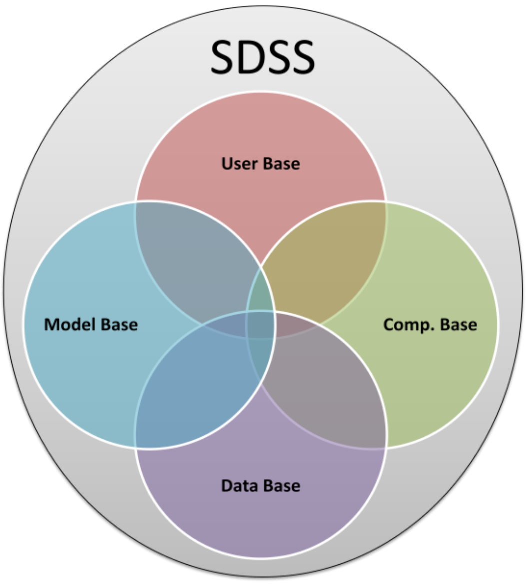


Figure 15: Conceptual model of principal Spatial Decision Support System components

4.1.2 Adoption of SDSS

Arguably, the development of computer technology since the 1990's has removed technological barriers to the implementation of a SDSS integrating data and model. As a result, the four components (database technologies, modelling tools, computational resources, and user interfaces) have each seen significant development during the same period. Access to large, spatially distributed databases over high-speed networks, the adoption of rich and highly interactive web-based graphical interfaces, and the wider accessibility of data through open data initiatives and crowd sourcing has opened the door for more decision makers and users actively participating in spatial decision-making. However, challenges remain and the field of SDSS has not yet reached maturity (Case 2001; Malczewski 1999). Relatively few full featured and integrated SDSS have been implemented and evaluated in real-life applications (Ascough et al. 2002).

Wilson (2008) cites examples of the potential for SDSS in the development of evidence-based policies, specifically in the spatial context of cities and city-regions, for which he coins the term "CityIS," or at a national level, "GovIS." He notes that the technical capabilities for the development of "what-if" forecasting models for spatial decision-making have been available for decades, and indeed such SDSS have been widely implemented in the private sector (for example, by retailers). However, Wilson notes a distinct reluctance on the part of central or local government to implement joined up policy decision-making. This he blames partly on a lack of skilled practitioners, as well as a distinct silo thinking along departmental and professional boundaries (economics, statistics, social, and operational), making the development of an integrated approach to planning and problem-solving hard to achieve. As a result, it is less technical issues that have hampered the implementation of truly integrated SDSS in the past decades, but rather organisational issues hindering integrated thinking and decision-making.

This research thesis presents a clear opportunity for joined-up thinking in the development of a more holistic view of location decision-making, embracing a multitude of users. The integration of a wide set of location variables, synthesis, and presentation in an accessible and interactive format with the aim of location analysis and decision-making enables the promotion of both more informed decision-making and analysis of the economic competitiveness of cities. These goals fit in well with the research goal of this thesis for the development of a robust spatially-enabled methodology for the quantification and qualification of intra-city business location decision-making, representing a holistic approach to location decision-making and analysis in cities as outlined by Wilson (2008).

4.2 A research framework for the development of a SDSS

The previous section exposed the potential of Spatial Decision Support tools and systems to help urban spatial decision-making in general. It also highlighted the general psychological constraints in managerial decision-making, including those specific to FDI business location decision-making, and the unfamiliarity of investors with London's heterogeneous business landscape. Given the importance of the location decision in establishing a successful presence in London, the potential of SDSS to guide potential investors through the complex business site selection process, and improve the evaluation and selection of investment locations is evident.

A possible approach to evaluate and define a research framework guiding the development of a SDSS for business location decision-making is given by the conditions highlighted by Densham (1991):

> ***An explicit design to solve ill-structured problems:*** The design and implementation of the components of the SDSS presented in this thesis will need to be grounded in an

understanding of business location decision-making. The complex and ill-structured nature of these processes can be explored through a review of both primary and secondary sources. This understanding of the factors and processes influencing decision-making then results in the formulation of both a relevant data framework, as well as a multi-criteria decision-making model enabling the capture and analysis of the very diverse qualitative and quantitative decision-making involved in business site selection.

Capability of supporting a variety of decision-making styles: Given the differential decision-making processes and variables involved in business site selection, the proposed SDSS will need to be able to adapt to individual decision makers' preferences, both rational factors as well as irrational decision-making. From individual evaluation criteria, the system will need to make a choice of one or more location alternatives out of all the locations available. This will be achieved through a review and evaluation of relevant Multi-Criteria Decision Making methodologies enabling the capture, processing, and integration of individual decision factors and location options into a relevant decision-making model.

Ability to combine analytical models flexibly with data: The choice of a Multi-Criteria Decision Making methodology and development of a decision model taking into account individual preferences will make possible the integration of the decision-making model with the spatial database. This is important as different users of the system will most likely have different decision-making strategies, preferences, and trade-offs, placing different values on variables and relationships. In addition, different users are likely to interact with and use resulting information in various ways.

Input of spatial data into the system and representation of spatial relations and structures: The development of a relevant solution space of location alternatives relies on a spatial data framework relevant to business location decision-making, enabling the development of a relevant geography of possible business locations.

Spatial and geographical analysis techniques: Following established practice developed in the wider context of geodemographic classifications, a geo-business classification of business neighbourhoods will be developed to process the initial spatial database of location variables into a coherent characterisation of different business environments, enabling the comparison and ranking of business neighbourhoods.

Ability to explore the solution space by building alternatives: The expression and modelling of decision makers' location preferences through a relevant MCDM methodology and evaluation of these preferences against the geo-business classification enables the definition of a solution space of possible business locations. Against this solution space decision makers' preferences can be evaluated to enable the generation of candidate investment locations, ranked according to the location preferences of the individual investor.

Allowing interactive and recursive problem solving: The choice of the MCDM methodology will also influence the recursive nature and degree of interactivity of the decision-making model, supported by the user interface. Through the choice of a suitable MCDM methodology, a decision-making process will be developed, enabling decision makers to express their location preferences easily, against which the business neighbourhoods will be evaluated and ranked, presented to the user in a highly interactive interface allowing the exploration and comparison of location recommendations. This is envisioned as an iterative process enabling the decision maker to return and change his location preferences, with the system then re-evaluating the solution space and presenting a new set of recommendations for the user to explore.

Output in a variety of formats, including maps, graphs: The user interface component of the system will guide the decision maker through the decision-making process, capturing the location preferences, and presenting the resulting location recommendations. Given the iterative nature of the decision-making, the location recommendations produced by the system need to first allow the comparison and evaluation of alternative business neighbourhoods. Next, the geographical context of the different business neighbourhoods will need to be visualised through an interactive mapping interface, along with ancillary visualisations of the relevant location characteristics. Using graphs and charts to compare locations will allow the user to understand the relative benefits of different location options and evaluate the outputs of the decision model.

The discussion of Densham's framework then justifies and specifies the salient features of SDSS that make it a suitable research framework for the development of a relevant and appropriate decision support system framework to support business location decision-making.

4.3 Conclusion

Through the review of the development of Decision Support Systems and the specific context of Spatial Decision Support Systems, a better understanding of both the defining salient structure and functionalities required for the development of a SDSS emerged, as well as the potential of SDSS in the development of a more holistic approach to location decision-making. The support of location analysis and spatial decision-making in particular, marks SDSS as a promising research framework enabling more informed decision-making. SDSS as a research framework has the capabilities to support and fulfil the stated research goal of this thesis, the development of a robust spatially enabled methodology for the quantification and qualification of intra-city business location decision-making.

In addition, the detailed discussion of the structure and essential functionality to support business location decision-making highlighted a number of essential resources needed to build an effective prototype demonstrating the potential for decision support in the context of this thesis case study. The four SDSS components represent a concise reference frame for the implementation of the research objectives detailed in the Introduction. Specifically, the three main research objectives, along with their associated sub-objectives can be matched to the three main SDSS framework components (see Figure 15):

1. *Understand London's diverse and polycentric business environments*, by creating a **spatial database component** able to build a comprehensive, relevant, and parsimonious picture of London's diverse business neighbourhoods, according to the most significant business location variables.
2. *Formalise business location decision-making* by developing a **model base component** implementing a relevant Multi-Criteria Decision Making methodology able to capture, analyse, and prioritise investors' location preferences to generate location recommendations.
3. *Support business site decision-making through an integrated prototype system* representing a relevant **user (interface) component**, able to guide and support the user through the location decision-making process according to the model developed, allowing the geo-visualisation and exploration of location recommendations.

The fulfilment of the overarching research objectives matched to the different SDSS components is supported by the fourth component, **computation base** (infrastructure), enabling the efficient support of the decision-making process, analysis of variables, and generation of location recommendations.

The research framework informs and guides the development process of the research thesis goal of developing a better understanding and support of business location decision-making. The approach detailed here represents an example of the potential of joined-up thinking in the analysis of a wide set of location variables, coupled with synthesis and presentation in an accessible and interactive format, together enabling more informed decision-making.

The following chapters detail and review the implementation of the research framework. Chapter 5 – "Spatial database" presents the development of the spatial database of business location variables, grounded in the previously presented data framework of business location variables. Combining the spatial database of location variables with a relevant geographical framework of the case study area, chapter 6 – "Geo-business classification for London" presents further analysis of the spatial database, arriving at the development of a geo-business classification enabling the characterisation and classification of London's diverse business neighbourhoods.

Chapter 7 – "Multi-Criteria Decision Making model base" presents the development of a relevant decision-making model base, first reviewing a selection of relevant MCDM, discussing their merits and drawbacks, to arrive at a conclusion on the most appropriate methodology to implement. Finally, chapter 8 – "Prototype SDSS implementation" presents, in the context of the implementation of a prototype SDSS, an account of the development of an efficient computation base environment integrating the model and database through a modern server/client infrastructure. The prototype enables the processing of users' preferences and the generation of solutions, as well as a user-friendly interface (user base) by which to expose this spatial database and guide users through the decision-making process.

5 Spatial database

This chapter presents the first step in the development of a database component suited for integration into the proposed Spatial Decision Support System. The development of this database component is based on the knowledge of location variables influencing location decisions at the intra-urban scale. This knowledge drives the development of a data framework of critical factors and processes that drive company decisions regarding location selection. The previous experience gained in the development of a Geographical Information System for FDI promotion vindicates in practice this location variables framework.

This chapter addresses the evaluation and collection of datasets suitable to model the most significant location variables relevant to business location decision-making. A second necessary step is the spatial integration of these datasets into a coherent and relevant geographical framework. A consistent geographical framework for the case study area enables the development of a geo-business classification allowing the characterisation and classification of London's diverse business neighbourhoods. This geo-business classification forms the database component of the SDSS.

5.1 Business location variables framework

Prior to the development of this research thesis, the potential of geographical analysis in the collection, analysis, and presentation of data to support location decision-making and to promote London as a candidate destination had been demonstrated in the presentation of specific location variables of interest to potential business investors into London. The univariate mapping capability proved to be very useful in marketing London to potential investors and providing basic location consultancy services. The spatial database proved to be useful to business location decision-making in the context of FDI into London and provided valuable intelligence on the basic data framework needed for the development of a SDSS spatial database component.

In the context of this thesis, this work is supplemented to support the unified data framework for business location decision-making previously developed in section 3.1.4:

1. the discovery, quantification and qualification of industry sector clusters (*Companies*),

2. the characterisation of the available talent pool and daytime population (*Workforce*),
3. quantity and quality of the *Property Stock*,
4. a more general appreciation of the living environment (*Liveability*) of London neighbourhoods,
5. the *Accessibility* through public transport of different neighbourhoods inside London.

This section focuses on the practical implementation of a spatial database component relevant to FDI location decision-making in London, presenting a selection of datasets suitable to represent and model the five major domains of location knowledge previously detailed in the data framework. These datasets are subsequently integrated into a coherent geographical framework of London's neighbourhoods.

5.1.1 Companies

The co-location between similar firms, either acting in the same or similar industry sectors, is an important business location variable for all companies, including FDI investors. Information frequently requested in the context of FDI promotion includes sector activity locations in order to present potential investors with an overview of economic activity patterns across London.

For the analysis of industry sector clusters, two main data sources are available. Commercial company databases, such as Dun & Bradstreet and OneSource, record essential information on companies and their business activities, number of employees, financial data, and site address information. From this data, lists of companies interesting to a specific FDI investor can be generated, representing potential partners, suppliers, or clients. Lists of existing or potential competitors can also be generated.

There are several problems inherent in using these datasets when aiming to generate small-scale industry sector statistics. There are no guarantees regarding completeness or correctness of the business records. Ancillary information attached to the business records, such as address details, financial and employment statistics are often misrepresented. Apart from missing or out of date data, for example, one business location, normally the company headquarters, can be recorded as accounting for the totality of business workforce or financial performance. Given the commercial nature of these databases, the download of large sets of data to produce complete lists of all companies operating in London is not financially viable, and sector-specific lists need to be restricted to a specific set of companies. These limitations pose serious problems for this research project, as it would be too financially onerous to generate a complete picture of London's economic activities using these types of sources.

By contrast, the Annual Business Inquiry (ABI) is available as a government statistical dataset. The ABI dataset is built from a sample from the IDBR (Inter-Departmental Business Register), the comprehensive UK business register used for the generation of statistical data on companies and economic activity. The ABI includes all UK businesses registered for either the Value Added Tax (VAT) or Pay As You Earn (PAYE) (Office of National Statistics 2008). From this data source, a sample of 66,000 businesses was drawn, designed to give the best available estimates of business population totals (Office of National Statistics 2008). The ABI dataset is generated from this sample, through aggregation of individual units to Standard Industrial Classification (SIC), employment size, and local units. The ABI variables available include number of enterprises, total turnover, approximate Gross Value Added, purchases, and number of employees. A set of financial indicators are also provided.

For this study, ABI employment statistics aggregated at the LSOA[30] level were used. Counts of employment in individual 4-digit SIC classes were aggregated into meaningful industry classes relevant to the economic situation for London based on target sectors[31] specified by the LDA (2003). These target sectors offer a relevant and easy to understand framework to analyse economic activity patterns in London. They detail the most important sectors of the London economy and are also used by the LDA to set specific targets in terms of job creation for FDI promotion agents. A second measure of the business environment is the average workplace size, in terms of number of employees per workplace (firm) in a given area. The ABI publishes data on the number of workplaces, which can be equated to a company, and the number of people working in a specific area. The ratio of employees divided by workplaces represents the average size of a workplace, as a proxy for average company size. Refer to Table 9 for the list of retained variables.

[30] LSOA is the abbreviation of Super Output Areas, Lower Layer. In England and Wales, Super Output Areas (SOAs) are a geographic hierarchy designed to improve the reporting of small area statistics. Unlike electoral wards, SOA layers are of consistent size across the country and will not be subjected to regular boundary changes. The 34,378 Lower Layer SOAs in England (32,482) and Wales (1,896) were built from groups of Output Areas (typically 4 to 6 each) and constrained by the boundaries of the Standard Table (ST) wards used for 2001 Census outputs. SOAs have a minimum population of 1,000 (Office for National Statistics 2008).

[31] Refer to Appendix 11.3 – "Lookup table for LDA Target Sectors to SIC classes" for the industry sector definitions.

Unfortunately, SIC classifications only record the industrial sectors in which companies operate. They do not encode any functional division of labour. It is impossible to use the SIC classification to distinguish, for example, between a company headquarter and its production facilities. For example, it is not possible to make a distinction between a pharmacological research and development centre and a drug production facility. Using an ABI-based industry sector view of economic patterns, these two activities are deemed equivalent, even though it is obvious that the drug research facility would require a different set of workforce skills when compared to a production facility. Although this information would be very useful for a better understanding of the economic landscape of London, functional descriptions of economic activities are not available in any current London-wide dataset.

Table 9: Companies data framework

Class	Source	Variables		Geography
Companies	Annual Business Inquiry 2007	Creative industries	Environmental	LSOA
		Higher Education & Research	Construction	
		Health	Retail	
		Social work	Transport & logistics	
		Tourism & leisure	Charity & voluntary	
		Utilities	Life sciences	
		Professional services	Pharmaceuticals	
		Financial services	Medical equipment	
		Food & drink	Manufacturing	
		ICT	Real estate	
		Ratio of Workplaces over Employees		

5.1.2 Workforce

As previously noted, the ABI data characterising employment patterns contains no details of the functional or socio-economic makeup of the local workforce. In order to derive more detailed profiles of employment patterns, it is necessary to characterise the workforce across different areas of London. The definitive data source for population statistics is the 2001 UK Census. In the Census, respondents had to identify both their place of residence and their place of work. From this, daily flows of workers from residence to workplace, provided as matrices, are generated for all wards of origin to all wards of destination. There are counts of every area-to-area flow in the UK (each cell in the matrix), with breakdowns of the characteristics of the people in the flow. Using this data from the Special Workplace statistics (2001), it is possible to access commuting flows at the Census Ward level.

This capability removes a serious limitation from the usual Census dataset, namely that census data normally refers to the resident population of an area. Through access to the Special Workplace Statistics, a link is established between employees at their place of work or study and broader socio-economic data captured in the Census relating to their place of domicile. From this link, geo-demographic characterisations of the day-time population of sub-regions and neighbourhoods of London become then possible.

The National Statistics Socio-Economic Classification has been constructed to measure employment relations and conditions of occupations. As such, this classification represents the best approximation of the local workforce skill set and employment status (see Table 10). The workforce data is recorded in absolute numbers of people per category, recorded at their place of work[32].

Table 10: Workforce data framework

Class	Source	Variables	Geography
Working Population	Census 2001: Special Workplace Statistics	Higher managerial and professional Occupations: - Large employers and higher managerial Occupations - Higher professional Occupations Lower managerial and professional Occupations Intermediate Occupations Small employers and own account workers Lower supervisory and technical occupations Semi-routine occupations Routine Occupations Never worked and long-term unemployed	Census Wards

5.1.3 Property stock

Another important facet of the makeup of London localities is the non-domestic property stock available to potential investors. Investors looking to set up a new business location in London need data on both the quantity and quality of the property stock. This information can be obtained from both commercial and government data sources. The commercial FOCUS database collects information on the commercial property stock across London. FOCUS records property transactions such as sales and lettings, and over time has built up a substantial database of commercial properties across London and the wider UK. FOCUS is

[32] Given that the place of work is of interest, the count of people in the category "*Never worked and long term unemployed*" by definition was nil for the whole dataset, and the variable was excluded from the database.

used by estate agents and other actors in the property sector to evaluate the property market and search for vacant properties. Unfortunately, FOCUS presents several fundamental drawbacks. Upon closer inspection, the quality and completeness of the data records regarding property transactions was found to be less than satisfactory, with significant data gaps specifically regarding property rental or sale prices. In addition, historical transaction data was only available at significant supplementary cost.

Data gathered by the government through the work of the Valuation Office Agency (VOA) provides an alternative source of property data. The VOA is charged with the collection of business rates, a tax on the occupation of non-domestic property, based on certain variables of the property. These include quality, size, and location, and consider the economic conditions prevalent at the time of the estimation. Rateable Value can be equated to a hypothetical rental value of the property, as judged by the estimator. Rateable Value can be considered a proxy variable for commercial property quality, and by extension, price and attractiveness.

All businesses must pay business rates, meaning that a rateable value is set for all commercial properties across the UK, published on a yearly basis. This indicates both the average rateable value per square metre for a set of classes of business premises, as well as statistics on the total premises stock. The Rateable Value statistics are complete, publicly available, and contain both indicators of quality/price of business premises and information on the total floor space for a set of business premises classes, such as factories, warehouses, retail premises, and offices (see Table 11).

Table 11: Property stock data framework

Class	Source	Variables	Geography
Property Stock	Rateable Value Statistics 2007	Rateable Value per square m. - All Bulk Classes Rateable Value per square meter - Offices Rateable Value per square meter - Premises Rateable Value per square meter - Factories Rateable Value per square meter - Warehouses Total Floorspace - Offices Total Floorspace - Retail Premises Total Floorspace - Factories Total Floorspace - Warehouses	MSOA

5.1.4 Liveability

The location factors relevant to FDI also include the need to qualify a more informal indicator of the quality of the urban environment. Such an indicator highlights the quality of the working environment, influencing the attractiveness to the workforce of the business location environment.

The Index of Multiple Deprivation (IMD) 2007 is a multiple indicator of deprivation structured into a series of domains, provided as a basis for policy making by the Department of Communities and Local Government (2009). These domains cover a range of economic, social, and housing issues into a single deprivation score for each small area in England. The IMD then allows each area to be ranked relative to one another according to their level of deprivation. Given the design of these measures, they have in the past mostly been useful in defining and analysing patterns of deprivation, as well as identifying areas that would benefit from special initiatives or programmes to address these social inequalities.

The IMD allows the addition to the spatial database of a small-scale indicator of the quality of the urban social and economic liveability of different location options (see Table 12). Describing mostly the resident population and local social infrastructure, this indicator then becomes a proxy for the general attractiveness as a place of work for companies looking to set up in London.

Table 12: Liveability data framework

Class	Source	Variables		Geography
Living Quality	Index of Multiple Deprivation 2007	Overall Score	Education, skills and training	LSOA
		Employment	Barriers to housing and services	
		Health and Disability	Living environment	
		Income	Crime	

5.1.5 Accessibility

In the context of this thesis, the concept of accessibility is highly relevant to FDI location decision-making. Accessibility can be defined as encompassing different transport modes at different spatial scales (access to local shops by foot, public transport travel times to other areas of the city, international flight times), as well as the concept of co-location with other activities. Given data availability limitations (see section 6.3.1.2 for a more detailed discussions of these limitations), two exemplar measures were picked to represent generalised public transport accessibility: public transport accessibility to Central London (as defined as the centroid for the Central London town centre boundary) as the main hub of business, social, and cultural activities, and accessibility to Heathrow (centroid of the Heathrow town centre boundary).

In order to obtain public transport travel time data, a custom “web scraping” script was developed which queried the Transport for London (TFL) “Journey Planner” website. Using postcode data for each town centre, the service was queried to report travel times from postcode to postcode for a typical Wednesday morning commute, arriving at the destination at 9 am. The script harvested from the results webpage the relevant html tags containing the time information, and saved this information for each journey query into a database table. For the generation of origins and destinations, each town centre boundary area’s geometric centroid was determined and the closest unit postcode to the centroid entered in “Journey Planner” to represent the origin of the journey. The destinations, in this case Heathrow and Central London were also added as the unit postcodes closest to the geometric centroids of the town centre areas. For each journey, the scraper entered the origin and destination postcode, along with the arrival time (9 am) into the Journey Planner.

The scraper script harvested journey times from each town centre in London to both Central London and Heathrow. Each journey query to the website took approximately 4 seconds. To not overwhelm this public web service, potentially resulting in a ban from the website, the data collection exercise was limited to those two example destinations. More ambitious data collection, involving travel times between each and all town centres, were not possible within a reasonable time frame.

5.1.6 Final data framework

In review, the datasets gathered were chosen as appropriate data proxies apt to capture and model the different FDI location domains detailed in the data framework previously developed in section 3.1.4. The previous section presented data sources able to represent each location variable, from various government data sources. The final spatial data framework assembled for this thesis is summarised in Table 13, containing 48 variables describing the five location domains.

Table 13: Initial data framework

Class	Source	Variables		Geography
Companies	Annual Business Inquiry 2007	Creative industries	Environmental	LSOA
		Higher Education & Research	Construction	
		Health	Retail	
		Social work	Transport & logistics	
		Tourism & leisure	Charity & voluntary	
		Utilities	Life sciences	
		Professional services	Pharmaceuticals	
		Financial services	Medical equipment	
		Food & drink	Manufacturing	
		ICT	Real estate	
		Ratio of Workplaces over Employees		
Working Population	Census 2001: Special Workplace Statistics	Higher managerial and professional Occupations: - Large employers and higher managerial Occupations - Higher professional Occupations		Census Wards
		Lower managerial and professional Occupations		
		Intermediate Occupations		
		Small employers and own account workers		
		Lower supervisory and technical occupations		
		Semi-routine occupations		
		Routine Occupations		
		Never worked and long-term unemployed		
Property Stock	Rateable Value Statistics 2007	Rateable Value per square meter - Offices		MSOA
		Rateable Value per square meter - Premises		
		Rateable Value per square meter - Factories		
		Rateable Value per square meter - Warehouses		
		Total Floorspace - Offices		
		Total Floorspace - Retail Premises		
		Total Floorspace - Factories		
		Total Floorspace – Warehouses		
Living Quality	Index of Multiple Deprivation 2007	Overall Score	Education, skills and training	LSOA
		Employment	Barriers to housing and services	
		Health and Disability	Living environment	
		Income	Crime	
Accessibility	TFL Journeyplanner	Public Transport Travel Time to Central London		Town Centre
		Public Transport Travel Time to Heathrow		

5.2 Geographic framework

Through the work in developing a spatial database relevant to business location decision-making, as detailed in the previous section, a large number of variables were gathered from a set of distinct datasets. These datasets are all recorded and distributed in a multitude of disparate boundaries and spatial units derived for administrative, regulatory, policy, and economic purposes. Apart from these identified datasets and their respective aggregation to spatial units, there are more examples of boundaries relevant to both FDI location decision-making and regional development policy work, such as:

- Travel to work areas spanning a number of the regional Development Agency boundaries, including the Greater London Authority, its 32 boroughs, and the City of London;
- The various geographies for Census and other statistics data aggregation; and,
- A number of strategic “Intensification” and “Opportunity” areas as defined by the development policy of the London Development Agency (2005).

On top of the multitude of existing formal administrative, political, and statistical boundaries, one of the most common requests by FDI promotion experts was for mapping of the distribution of existing business locations and their workforce catchments. These specific requests indicate a need for functional boundaries matching the scale at which economic activities take place. Perhaps unsurprisingly, these maps demonstrated little correspondence with existing administrative boundaries, with concentrations often appearing at the intersection of different jurisdictions (see Figure 16). The exploration of FDI clustering patterns developed in section 3.2 - "Exploratory analysis of FDI” also presented relevant evidence for the spatial structure of London’s economic landscape, and specifically the scale at which FDI firms cluster. Specifically, firms are seen to cluster and locate at the neighbourhood level.

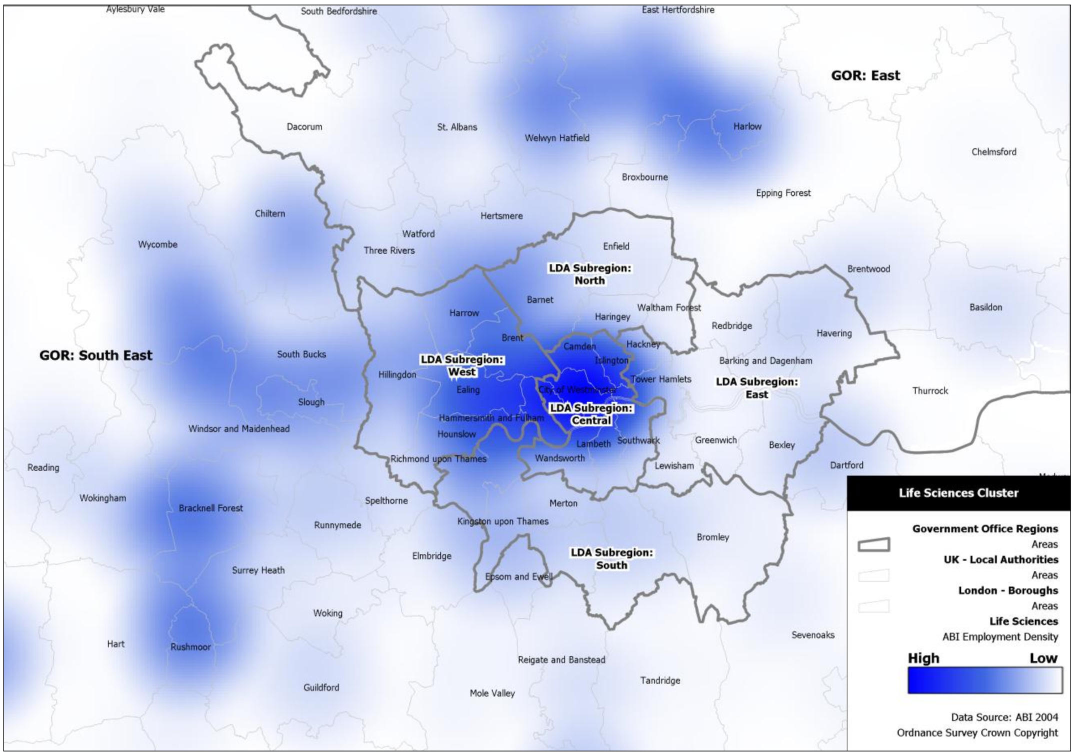


Figure 16: Life sciences employment density overlaid with administrative boundaries

The need for a geographic framework recognising London's business landscape and spatial scale of FDI location decision-making, irrespective of existing administrative or political boundaries, is also evident from the experience gained in the implementation and operationalisation of a FDI GIS capability (Weber & Chapman 2009). The development of a spatial database component to support business location decision-making clearly necessitates a relevant and succinct characterisation of London's diverse business neighbourhoods, captured in a unified geographic framework by which to delineate and define such neighbourhoods. This geography of London's business neighbourhoods then forms the basis in which to frame location choices and relevant variables, facilitating the coherent import, aggregation, analysis, and presentation of outputs.

In the following section, a review of existing efforts at defining area profiles inside London is presented. This case study reviews a qualitative approach to defining and qualifying Central London areas relevant to FDI investment decision-making. Given the qualitative and poorly delineated nature of the actual areas, a new London neighbourhood geography is proposed, aggregating the existing spatial datasets in a unifying geographical framework delineating areas relevant to FDI location decision-making.

5.2.1 Case study: A qualitative approach to area profiles

To date, London's FDI promotion activities have been organised around a subdivision of the Greater London Authority into five subregions and their constituent boroughs. However, this very top down subdivision of London according to a basic administrative geography does not represent the most appropriate spatial model by which economic processes, and indeed FDI promotion activities, are developed. Indeed, within these subregions, regional business development managers have developed an implicit knowledge of the local business landscape at a much finer geographic scale of individual districts and neighbourhoods, from which they draw informed location advice. Their knowledge of the business landscape comes from their personal experiences gained from dealing with hundreds of companies. However, this local intelligence is not systematically recorded, making it difficult to present robust and consistent inter-regional comparisons.

In recognition of this, London's official FDI promotion agency, Think London, implemented a pilot project to capture, codify, and extend the tacit knowledge of their regional staff through a series of "Area Profiles", which incorporate additional qualitative research drawn from interviews with local businesses (Think London 2006b). Area profiles characterise key factors of the existing business landscape, along with indications of specific clusters of activity. They enable the development of marketing propositions for specific client types. One example is the area profile for Camden, which is described as:

> *" …one of London's most recognisable tourist destinations. It is famous for its vast network of markets that have set trends across the world for emerging fashion and have launched many internationally known fashion designers. It is also a hotbed for creative music talent – the heart of new British music and the birthplace of Punk and Brit-Pop. Musicians including Madness, Blur, Oasis, Morrissey and the Libertines all have strong connections with Camden Town. A worldwide reputation for grass roots music and fashion has cultivated a strong commercial hub for media and design led businesses."*

The area profile also lists the following main benefits for businesses locating in Camden:

- An excellent network of like-minded businesses;
- A creative urban atmosphere;
- Quick access to the UK and Europe, via Eurostar;
- Quick access to all parts of Central London;
- Easy access to high calibre, creative staff; and
- Excellent availability of high quality office space.

These statements are supported and brought to life by quotes taken from interviews with companies representing typical businesses locating in Camden[33]. Area Profiles stress the importance of human and creative capital as the main focal point around which the picture of a competitive and thriving neighbourhood is built. This works well in the example of Camden, drawing on its rich cultural and musical heritage. The Area Profiles produced for other London neighbourhoods have a similar structure. These profiles implicitly contain a data framework that puts an emphasis on skills, experience, creativity, and knowledge of the local workforce, along with a geographic framework highlighting the existence of regional and neighbourhood activity clusters and networks, supported by a strong identification of companies within these specific places.

The development of such profiles has also been made popular in the context of the development of Business Improvement Districts in Central London. BIDs have emerged as public-private partnerships in a given urban area (neighbourhood) financed by a supplemental levy on local businesses. Through the involvement of local businesses and local government, these BIDS aim to address infrastructure and service problems. These local associations also develop a distinctive identity and marketing strategy for their area, aimed at making the area attractive to visitors and businesses. For example, five BIDs were set up as part of a pilot project by the London Development Agency in 2003, expanded to 20 operational BIDs in 2009 (LDA 2009).

[33] Pianoworks (Advertising, TV, radio and cinema): *"There is a useful cluster of advertising businesses in Camden which we undoubtedly benefit from. Because of this, or possibly as a result of this, recruiting young, dynamic and high calibre staff is easier here than elsewhere."* Susan Searle
Spirit Design Consultants: *"Accessing the right skills is fundamental to our business and Camden is excellent for this. It draws in a diverse range of individuals and skills compared to other locations in London."* Edem Agbotui

The qualitative definition of a set of rich and descriptive area profiles highlighting different London business neighbourhoods, either informally defined in the course of the pilot study, or formalised in the context of a BID, presents a novel approach. Significantly, these initiatives, independently of this research project, acknowledged and implemented a new alternative geography of London's neighbourhoods not based on pre-existing administrative, political, or social boundaries. However, this qualitative approach also has some severe limitations. The actual delineation of the areas in question is never formalised, given that the definition is qualitative, taken from interviews, rather than based on statistics. As a result, the boundary of a given neighbourhood is based on perceptions by individual interviewees. The descriptions of different neighbourhoods are not supported by "hard numbers" on which potential investors could rely to further compare and contrast different areas. Finally, this approach has only been tested as a pilot study using a very small set of areas in Central London. To replicate this exercise comprehensively across Greater London would prove difficult and would involve a lot of resources in order to build up a broad set of interviews covering all areas, from which to build these profiles.

5.2.2 Defining a geographic framework

> *"Greater London has come into existence as a construction from many individual towns and cities" (Hall 1999, p.115)*

Looking back at the history of London and its urban development, Greater London has been constructed from many individual seeds of development - hamlets, villages, and cities (Hebbert 1998; Thurstain-Goodwin & Unwin 2000; Ackroyd 2001; URBED 2002). These nuclei of urban development still survive today in an economic sense, with separate identities and differing characteristics, as well as socially, demographically, and culturally. As discussed previously in section 2.5.1, these modern urban nuclei persist as proof of the polycentric nature of London and one of the defining characteristics of London's economic landscape. Greater London then exists only as a polycentric urban construct, defined by the activities and interconnections between these nuclei.

A geography able to express this polycentric nature of London's business landscape was not available until 2001, when the Town Centres Statistics Project (Thurstain-Goodwin et al. 2001; Lloyd 2004) defined such boundaries of such local economic activity centres. In London, 208 town centres were identified in terms of their economic, social, and cultural activities, characterising the complex and polycentric nature of Greater London. The boundaries of these town centres are not based on existing delineations, but rather are defined along with attached economic and social statistical indicators for all towns falling within the M25[34] (later expanded to include the whole of England and Wales), with the aim of facilitating governmental monitoring of local town centre economies. The core datasets used are the Annual Business Inquiry and the Rating Support Application database for floor space and unit postcode locations for geo-referencing purposes. The methodology adopted uses kernel density estimation to smooth the postcode referenced town centre activity data, which produces a surface. The result of the research is the production of an 'Index of Town Centeredness', which forms thresholds defining town centre boundaries constrained by size and functional activity. The boundaries are known as "Areas of Town Centre Activity" (Thurstain-Goodwin et al. 2001; Lloyd 2004).

The economic agglomeration of activities, industrial clustering, in and around these urban nuclei in London also means that around 80% of all London employment is concentrated in and around town centres. The town centre boundaries dataset represents the quantitative expression of the nucleus constituting London "towns" described in history and defined previously through anecdotal evidence. Town centre boundaries then offer a relevant, consistent, and comparable geographical framework to aggregate disparate datasets, merged and compared in line with economic processes occurring inside the Greater London Area. They also provide the geographical framework for the provision of quantifiable and comparable indicators, fit to constitute the basis of a set of area profiles for Greater London.

5.2.3 Data normalisation

To allow the evaluation and comparison of different town centres of London, some sort of normalisation against the overall average has to be computed. There are several strategies available to allow comparisons between different areas. A commonly used method is the computation of a Location Quotient (LQ), see for example Leigh (1970), which represents a ratio between the employment proportion locally and the national average of this proportion, which can be derived from the following formula:

$$LQ_i = \frac{e_i/e}{E_i/E}$$

[34] Orbital motorway enclosing Greater London, often used as an unofficial boundary delineating London.

where e_i represents the local area employment in a specific sector, e the total employment in the local area, E_i employment in the specific sector and E total employment.

Location Quotients were generated for the ABI data representing the “Companies” component of the spatial database, the “Workforce” employment numbers, and the “Property” quantity indicators, i.e. floorspace in the different use categories. Rateable Value and the IMD indicators represent comparable indexes already and thus do not need to be normalised.

For the example of the ABI employment numbers, employee counts for each LSOA area are transformed to a Location Quotient, which computes the relative concentration of jobs in a particular sector, identifying whether a sector is over-or underrepresented relative to the overall London average. Location Quotients facilitate comparisons between the local existing industrial base and their relative importance, regardless of the total employment size within the spatial unit of analysis. Location Quotients enable the development of local activity profiles, which inform analyses of the relative attractiveness of a given area with respect to particular industries. The ABI target sector location quotients allow a quantitative analysis backing informal knowledge of the local economy. For example, the Location Quotient analysis very clearly demonstrates the great importance of the City of London and Canary Wharf in terms of the financial services industry sector.

An Information and Communication Technology (ICT) company, for example, may believe they should locate in the City of London (with an ICT LQ of 2.7). The map of Location Quotients for the ICT sector (Figure 17) shows that there is also a high concentration of ICT related businesses in alternative town centres, such as Croydon, with an ICT LQ of 2.0.

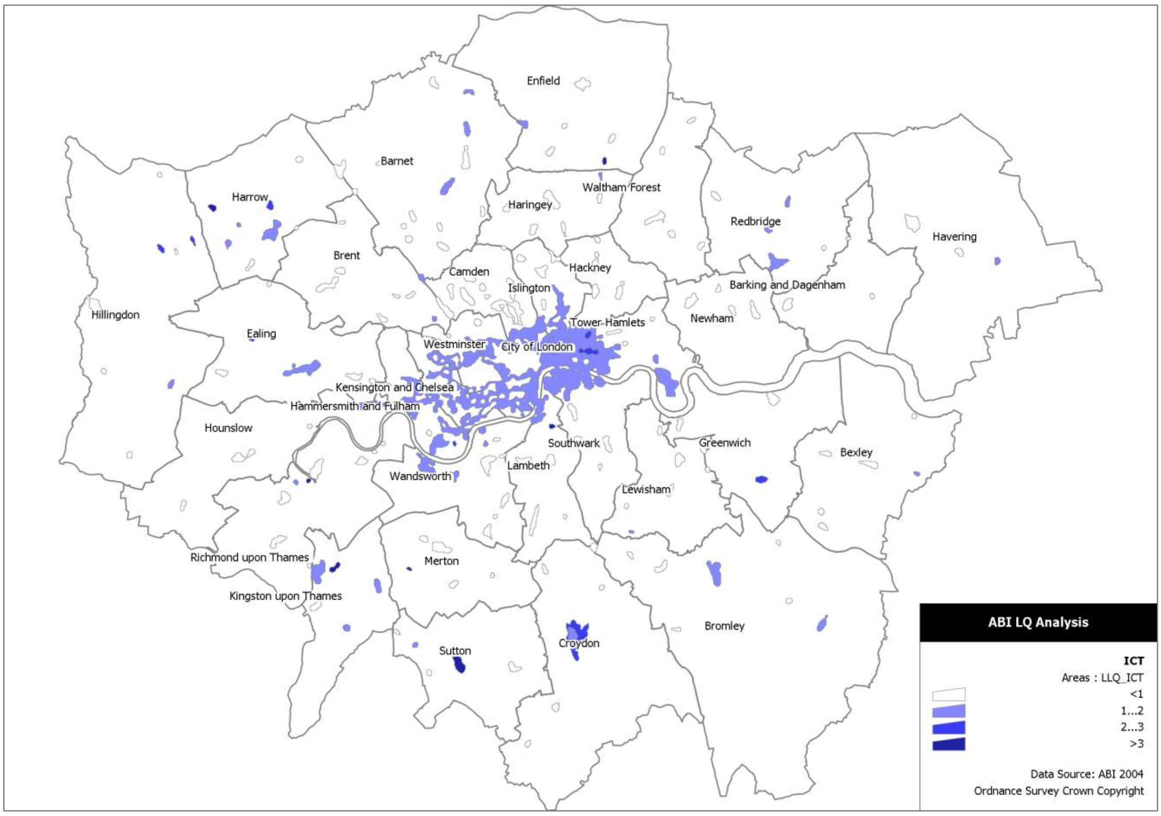


Figure 17: "Location Quotient" analysis of ICT target sector

5.2.4 Transforming variables into a unified geographic framework

Given that town centre boundaries are derived from a set of surfaces contoured to a specified threshold, they are not coincidental with any existing administrative, statistical, or political boundaries. There is a mismatch between the spatial database aggregated to a set of existing geographies (LSOA, MSOA, Wards), and the town centre boundaries. Figure 18 illustrates the problem for the town centre boundary of Canary Wharf. Although the town centre boundary describes the area of principal town centre activity, the boundaries for the individual wards holding data from the spatial database are not coincident. In fact, the town centre boundary intersects more than one ward boundary. The same effect applies to LSOA, MSOA, and any other common UK boundary datasets.

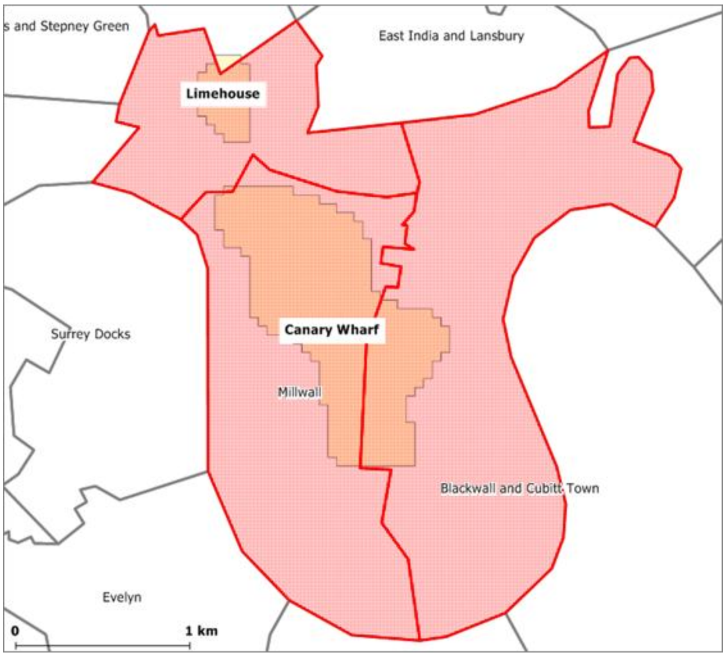


Figure 18: Canary Wharf town centre boundary with touching wards

To transform the spatial database of location variables, data is aggregated from the intersection between each town centre and touching spatial data units (see example in Figure 18). The aggregation process uses the average value of each variable from the town centre boundary intersecting geographic entities. This applies to both the variables expressed as Location Quotients, as well as ratios such as the rateable value per square metre. The town centre statistics inherit an average value of the surrounding spatial data units, as detailed in the data processing flow diagram in Figure 19.

Given the differing boundaries that various location variables are available in, the aggregated averages represent an approximation of both the actual town centre boundary conditions and a varying width buffer around the actual town centre. In the case of the development of Area Profiles, this overestimation of the data collection area allows the qualification of London neighbourhoods on a wider scale than the narrow view set by the town centre boundaries.

The only data that does not require an aggregation to the boundary are the accessibility indicators, as they are generated on a postcode level. In this case, the centroid postcode of a given town centre boundary is defined as the representative start- and end-point for the generated journey times.

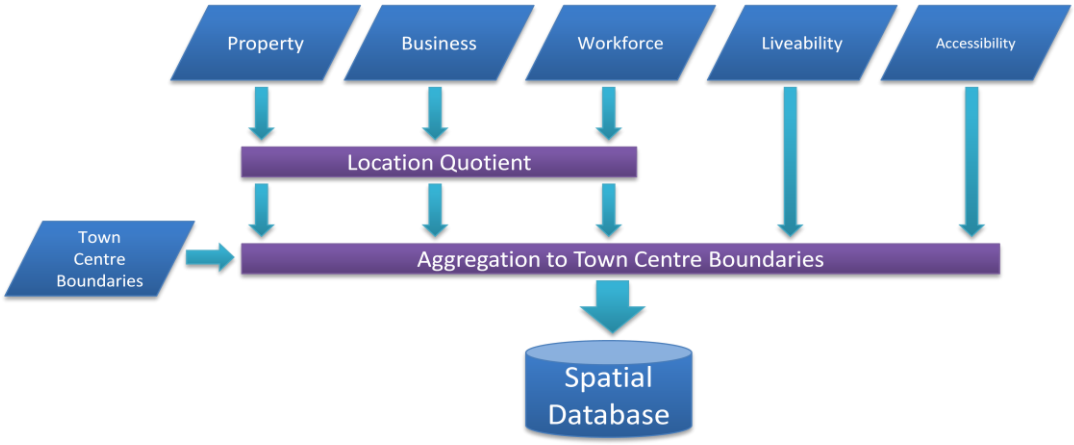


Figure 19: Development process for the spatial database

5.3 Conclusion

This chapter presents the first step in the development of a SDSS database component. The development of this database component is based on the knowledge of location domains impacting location decisions at the intra-urban scale. The implementation of this data framework relevant to FDI location decision-making leads to the selection of several statistical datasets, representing a set of location domains. These datasets are the Annual Business Inquiry data on the concentration of companies in specific sectors, the socio-economic census classification of the workforce, the Indices of Multiple Deprivation as indicators of general liveability of areas, the Rateable Value indicators quantifying and qualifying the property stock, and the public transport travel time accessibility data, totalling 48 variables (see Table 13). Although integrated into a spatial database, the individual variables are held in a set of conflicting geographies, making combinatory and comparative analysis difficult.

The development of a coherent geographical framework relevant to the task of representing London's business neighbourhoods is necessary for the aggregation of the spatial database variables to a common and relevant geography. Through a review of past work in defining area profiles, and the review of potential geographies, the London town centres boundaries dataset is deemed suitable as a common geographical framework of London business neighbourhoods. Through aggregation of the different datasets to the unified geography, as summarised in Figure 19, a rich spatial database is developed that will be used in the next chapter as the knowledge base for the characterisation and classification of different London business environments relevant to FDI location decision-making.

6 Geo-business classification for London

This chapter develops a methodology to enable the efficient exploration of areas of London exhibiting similar behaviours and characteristics, based on the previously developed spatial database. The potential of geodemographic methodologies to guide the development of a parsimonious and relevant characterisation of different business environments for location decision-making is explored and justified.

Expanding beyond a review of geodemographic methodologies, the implementation of a customised geo-business classification of London business neighbourhoods is detailed. A set of geo-business dimensions highlight different aspects of neighbourhood activities and characteristics relevant to business site location decision-making. Each geo-business class then describes a different business environment, and these classes are used to produce composite area profiles for each town centre. These area profiles can be used on their own to inform business site marketing and investor decision-making, but also form the final database component needed for the implementation of the proposed SDSS.

6.1 Geodemographics and their relevance to geo-business classifications

Geodemographics is a term, which in general applies to the analysis of social and economic data in a geographical context (Johnston 2000), commonly applied to the analysis of people according to where they live (Sleight 1997). Geodemographic classifications (also called neighbourhood classifications or typologies) cluster small areas based on the socioeconomic similarity of residential populations (Harris et al. 2005). The generic principle upon which geodemographic classifications are constructed relies on the fact that similar people live in similar types of neighbourhoods, go to similar places, do similar things, and behave in a similar manner.

One of the earliest examples of geodemographics is Booth's street-level poverty map of London. Developed from a survey of life and labour during 1886-1903, Booth developed a standard classification of London streets according to their residents' living and working conditions (London School of Economics 2009). Perhaps more relevant to the context of this research is the work by urban sociologists in the 1920s on theories of spatial and social structure of cities, often referred to as the 'Chicago School of Human Ecology'. Park, Burgess, McKenzie, and Wirth (1925) explore the relationships between urban characteristics and socioeconomic and cultural differences between populations and neighbourhoods. According to their models of urban structure, different areas of a city attract different land uses, according to competition, pressures, and constraints leading to the development of 'ecological niches'.

Subsequent work by authors such as Shevky & Bell (1961), influenced by the Chicago School of Human Ecology , led to the development of 'social area analysis', linking urban social structures and residential patterns to economic development and urbanisation processes. The growth of this field of study was driven by the availability of local population census data for the investigation of processes on a local level. The small-scale census data necessary for social area analysis was already available in the 1950s in the United States, while comparable quality data only became available in the UK with the 1961 census.

In 1969, as part of the Third Survey of London Life (Norman 1969), London's enumeration districts were classified into six socio-economic groups (upper class, bed-sitter, poor ...). This survey was to be one of the earliest precursors to the modern geodemographic classifications available from both commercial and public sector actors. These modern classifications cluster individuals and places into different types and groups according to similarities in their socioeconomic circumstances, lifestyles, and behavioural patterns.

Today, there are many commercial products providing rich profiles of local communities going beyond that which is normally provided by the Census. Commercial geodemographic classifications, such as Experian's Mosaic system which supplements Census data with information derived from county court judgements, company shareholder information and market surveys to develop consumer focused geodemographic classifications at the postcode level. The current implementation of Mosaic, for example, classifies consumers into 15 socioeconomic groups and 67 sub-groups (Experian 2009).

The Office for National Statistics (ONS) developed in cooperation with Vickers and Rees (2007) a geodemographic classification from key Census datasets, at the Output Area level (125 households). The Output Area Classification (2001) provides the socioeconomic character of different population groups at a local scale, useful in the profiling of populations, structuring of other data, and the targeting of resources, for example in public health.

Contemporary classifications are now widely used in business to provide operational, tactical, and strategic context to decisions that involve the fundamental question, "*where?"* (Longley & Clarke 1995) They are popular today in a multitude of fields, from survey design, direct marketing campaigns, to understanding retail location choices in terms of access to consumers and demand for retail locations (Harris et al. 2005, p.4). In the public sector, geodemographics are used in policing (Ashby & Longley 2005), higher education (Singleton 2004) and health (C. E. Jones 2008) to name just a few examples.

A methodology for developing a geodemographic classification follows several steps (Harris et al. 2005, chap.6):

1. Evaluation of potential data sources with respect to their reliability, robustness, and appropriateness to the geodemographic classification aims.
2. Absolute values need to be related to a base count. For example, the total count of businesses in one area is an absolute count. To make counts comparable between areas, they need to be related to the total count of businesses across all areas (the denominator).
3. Variables need to be transformed through standardisation (z-scores) to make them comparable. Standardisation issues include potential skew, i.e. variables that are not normally distributed.
4. Highly correlated variables need to be identified to enable the deletion of superfluous duplicate variables. This is done through the development of a minimum spanning tree highlighting such correlations, or a Principal Components Analysis, which identifies the main differentiating components of a group of correlated variables.
5. Selection of weights to be attached to the different variables.
6. Classification of neighbourhoods into a set of clusters through an iterative allocation-reallocation process such as K-means clustering. Individual clusters are grouped into types according to similarities.
7. Development of profiles for each cluster through the presentation of summary labels, portraits, indicative photographs, descriptive prose, charts, and maps.

The application of this methodological framework has to date been focused on the characterisation of residential population clusters, based on the age-old adage "*birds of a feather flock together*". However, it is apparent that companies also behave in a similar fashion by flocking together[35]. The drive to be competitive and tap into information, social, and knowledge networks leads businesses to locate near each other so that there is an inherent spatial autocorrelation to the pattern of business clusters resulting from the need for similar businesses to be located near each other.

The analysis and characterisation of local business neighbourhoods using geodemographic methods, not in terms of the resident consumers, but instead in terms of the business environment and existing firm 'population', is a field that has received comparatively little interest to date. There clearly is potential in the application of geodemographics, not only to B2C[36] site selection problems, but also B2B[37] business location decision-making. The following section proposes a novel classification of London neighbourhoods, adopting elements of geodemographic methodology, but shifting the analytical focus from modelling potential consumer markets to a more general appreciation of different local business environments and existing business clusters. The development of such a geo-business classification is made possible by the previous development of a spatial data framework for London, encapsulating relevant business location characteristics.

6.2 The need for a geo-business classification

The spatial database developed in the previous chapter contains a large set of variables deemed relevant to the FDI location decision-making process. The spatial database holds data on London's target sectors, the socio-economic classification of the workforce, the IMD, the Rateable Value indicators, and public transport travel times, 48 variables in total, aggregated to a common geographical framework representing business neighbourhoods.

Decision making, through comparison of business neighbourhoods along each of these 48 variables, is possible but remains cumbersome due to the number of variables and amount of

[35] See, for example Saxenian (1991) excellent contribution to detailing co-location benefits for Computer Systems firms in Silicon Valley, California.

[36] Business-to-consumer (B2C) describes activities of businesses serving end consumers with products and/or services.

[37] Business-to-business (B2B) describes commerce transactions between businesses, such as between a manufacturer and a wholesaler, or between a wholesaler and a retailer.

data involved, especially for non-expert users such as foreign direct investors. The application of some of the concepts of geodemographics to the spatial database then offers the potential reduction of the number of variables involved to a manageable level, as well as identifying and eliminating highly correlated variables, which obfuscate judgements on location options. Such an analysis also enables the development of a location classification, profiling locations according to the main distinctive characteristics for each class. The result of this analysis is a multifaceted description of different environments and the attribution of measures of similarity to multiple urban environments for a given neighbourhood. Such a geo-business classification allows the meaningful and rich description of London's diverse business neighbourhoods.

Given the specific requirements posed in the context of FDI promotion activities, the following sections detail the development of the proposed geo-business classification of London town centres. From this analysis, summarised in Figure 20, a multi-dimensional geo-business classification of London business neighbourhoods emerges, enriched by a set of rich profiles describing the different business environments. The geo-business classification then forms the database on which to build a decision support tool allowing investors to compare, contrast, and rank location options across London.

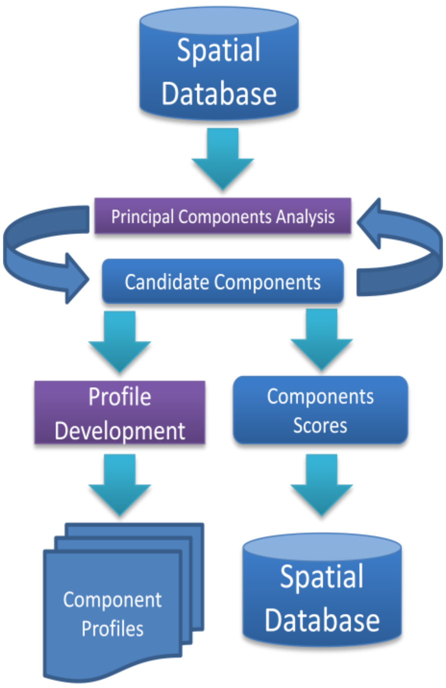


Figure 20: Process for the construction of the component profiles

6.2.1 Principal Components Analysis

In exploratory analysis models of highly dimensional datasets, one of the techniques commonly used to uncover a variable structure is a Principal Components Analysis (PCA). PCA and another closely related methodology, Factors Analysis (FA), belong to the family of eigenvector-based factor analysis methods. However, PCA and FA differ in their method for generating factors (components). PCA is used principally in exploratory analysis, where the researcher wants to reduce a large number of variables to a smaller number of components, discovering an underlying set of latent dimensions. PCA seeks to reproduce the total variance of the variables, making it a variance-focused approach. In contrast, FA is used in causal modelling in conjunction with techniques such as path analysis or structural equation modelling. FA seeks to reproduce the covariation between all variables, making it a correlation-focused approach. For a detailed discussion of the methodology of Factor Analysis and PCA, refer to Robinson (1998, p.121).

Given the aims in this thesis of the simplification of the spatial database to enable the development of a parsimonious characterisation of different geo-business environments, PCA provides a useful analytical framework.

PCA, first developed by Pearson (1901) , transforms a number of possibly correlated variables into a smaller number of uncorrelated variables, commonly referred to as principal components, which represent differentiating factors or components of a group of correlated variables (Robinson 1998). In other words, the aim of PCA is parsimony (Dunteman 1989, p.8). PCA does this by seeking a linear combination of variables with the maximum variance extracted from the original variables, resulting in a first component. It then removes this variance and seeks a second linear combination explaining the maximum proportion of the remaining variance, creating a second component. This process is repeated until all of the variance can be explained by these new components. The structure of these principal components is such that the first component accounts for as much data variability as possible and each succeeding component thereafter accounts for a decreasing amount of variability.

In the context of this work, PCA is used to reduce a large set of input variables concerning companies, working population, property stock, living quality, and accessibility to a new set of components, which model the common and unique variance of the original variables. From this analysis, the components describe different aspects of London’s town centres, aggregating both positively and negatively correlated variables, allowing for the development of area profiles.

The application of PCA to the study of urban and social structures can be traced back in the British Isles to a study of inter-urban social and economic differences (Moser & W. Scott 1961), followed by a number of intra-urban investigations of urban-socio-economic structures. These studies were all concerned with the identification of urban structures and patterns to form a basis for comparison with existing generalised models of urban form (Herbert 1968). Later work concentrated on social aspects and spatial urban patterns of deprivation, such as the Liverpool Malaise Study (M. Flynn et al. 1972), serving as precursors to the development of geodemographic classifications (Derbyshire 1983). A later example of PCA used in the characterisation of populations can be seen in the development of the *SuperProfiles* geodemographic classification, derived from the 1981 UK Census, detailed by Charlton et al. (1985).

6.2.1.1 Preliminary variable selection

Prior to the PCA, a cross tabulation table (see Appendix 11.4) of the correlation coefficients of all variables allows the identification of highly correlated variables within one domain. For example, the cross-tabulation table shows that the IMD component scores are highly correlated to the overall composite score. This is obvious as the overall IMD score is computed from the individual component scores. In order to simplify the dataset analysis, and given the need for only one measure of overall "liveability" of town centres, the individual IMD Component scores can safely be excluded from the PCA.

The rateable value dataset also contains both an overall indicator of rateable value per square meter and floor space and data on individual property classes. In this case, the distinction between individual property classes such as retail, offices, or warehousing, is deemed relevant to decision-making, and thus the redundant overall indicators can safely be eliminated from the dataset. There is no similar redundancy in the other data domain variables, such as the ABI data on individual business sectors, as they have been defined precisely as being relevant to London's economy by the London Development Agency (2003).

The PCA is implemented in many statistical computation packages such as the SPSS statistical software package. SPSS standardises (using z-scores) all input variables in the PCA analysis, as a necessary pre-condition for a meaningful analysis of the variables and interpretation of the results. As such, there is no need for prior user intervention to manually generate standardised variables.

The accessibility measures contained in the spatial database were not used in the PCA analysis. Accessibility is considered in the context of FDI location decision-making to be heavily dependent on individual requirements of FDI investors, dependant on their industry sector, function, and country of origin. Both attraction (i.e. co-location with potential suppliers, partners, and customers) and repulsion (i.e., the desire to be located away from competitors) are relevant accessibility and location variables. These highly individualistic accessibility requirements could not be satisfactorily modelled given the aforementioned data access limitations. For each town centre, only example travel times to Heathrow and Central London were included. In addition, the geo-business classification is designed as a set of generic area profiles representing environments of interest to all investors. The individualistic nature of accessibility preferences then precludes the integration into such a general characterisation. Instead, accessibility is modelled in the final decision-making process as a separate variable to the general business environment.

From these considerations, the final data structure used in the PCA analysis is presented in Table 14. This dataset is then the starting point for the PCA analysis.

Table 14: Final data framework retained, variables aggregated to town centres

Class	Source	Variables	
Companies	Annual Business Inquiry 2007	LQ - Creative industries	LQ - Environmental
		LQ - Higher educ. & research	LQ - Construction
		LQ - Health	LQ - Retail
		LQ - Social work	LQ - Transport & logistics
		LQ - Tourism & leisure	LQ - Charity & voluntary
		LQ - Utilities	LQ - Life sciences
		LQ - Professional services	LQ - Pharmaceuticals
		LQ - Financial services	LQ - Medical equipment
		LQ - Food & drink	LQ - Manufacturing
		LQ - ICT	LQ - Real estate
		Ratio of Workplaces over Employees	
Working Population	Census 2001: Special Workplace Statistics	Higher managerial and professional Occupations: - LQ - Large employers and higher managerial Occupations - LQ - Higher professional Occupations	
		LQ - Lower managerial and professional Occupations	
		LQ - Intermediate Occupations	
		LQ - Small employers and own account workers	
		LQ - Lower supervisory and technical occupations	
		LQ - Semi-routine occupations	
		LQ - Routine Occupations	
Property Stock	Rateable Value Statistics 2007	Rateable Value per square meter - Offices	
		Rateable Value per square meter - Premises	
		Rateable Value per square meter - Factories	
		Rateable Value per square meter - Warehouses	
		LQ - Total Floorspace –Offices	
		LQ - Total Floorspace - Retail Premises	
		LQ - Total Floorspace –Factories	
		LQ - Total Floorspace - Warehouses	
Living Quality	Index of Multiple Deprivation 2007	IMD 2007 – Score	

6.2.1.2 Discussion of outputs

The output listing of the PCA (run in SPSS) can be found in Appendix 11.4.2. Apart from the input variables considered and the choice of the output graphs supporting the interpretation of the results, the analyst has to decide if, and which, rotation method needs to be applied to the results. In PCA, post-processing of the resulting loadings can be applied through a rotation method such as the VARIMAX rotation. Varimax rotation is an orthogonal rotation of the component axes, maximising the variance of the squared loadings of a component (column) on all the variables (rows), which improves the differentiation of the original variables by extracted component. Varimax was chosen over other rotations to minimize the complexity of the components. Varimax rotation yields a solution, which makes it as easy as possible to identify each variable with a component, where each component will have either large or small loadings with any particular variable. SPSS generates the optimum rotation solution using an iterative approach, in this case reached after a maximum of 250 iterations. The results used in this analysis are from the rotated solution.

The principal output from the PCA (see Table 15) is the generated components in decreasing order of contribution to the overall variance of the constituting variables. The eigenvalue of a given component measures the variance in all the variables that is accounted for by each component. PCA generates as many components as there are variables in the dataset, with each component responsible for a decreasing amount of variance not explained by previous components. Given that PCA is intended to eliminate duplicate information, the actual number of components retained is smaller than the number of initial variables, but large enough to explain a certain threshold of variance among the variables.

The plotted eigenvalues of the individual components help make an informed decision on the threshold beyond which supplemental components only add little to the model. Alongside subjective appreciations by the researcher of the interpretability of a given component, i.e. does a component make any sense and be interpreted, a commonly accepted cut-off criterion is when the eigenvalue of a component drops below a value of 1 according to the Kaiser criterion (Kaiser 1960). There are numerous other methods to determine the component number threshold. For a detailed discussion and evaluation, see Jackson (1993).

Table 15: Eigenvalues of components and their cumulative contribution to total variance

	Total Variance Explained						
	Name	Initial Eigenvalues			Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	Urban professionals	7.943	20.368	20.368	4.602	11.800	11.800
2	Blue Collar Industry	4.606	11.810	32.178	4.069	10.433	22.233
3	Blue Chip Finance	2.942	7.543	39.721	3.324	8.523	30.756
4	Third Sector Centres	2.407	6.171	45.892	2.832	7.262	38.018
5	Big Sheds and Trucks	2.174	5.575	51.468	2.508	6.431	44.450
6	High (End) Streets	1.756	4.503	55.970	2.405	6.168	50.617
7	Creative & Green M.	1.460	3.742	59.713	2.298	5.893	56.511
8	Sights of London	1.397	3.582	63.294	1.678	4.302	60.812
9	Ivory Towers	1.215	3.115	66.410	1.602	4.108	64.921
10		1.130	2.898	69.307	1.476	3.784	68.705
11		1.098	2.816	72.124	1.333	3.419	72.124

Given the Kaiser criterion (eigenvalue > 1), 11 components from the PCA account for about 72% of the total variance of all variables across all town centres. Another possible indicator for the choice of component threshold is the "Cattell Scree Plot", shown in Figure 21. This plot draws the components on the X axis, and the corresponding eigenvalues on the Y axis. In other words, the plot represents the decreasing additional variance explained by subsequent components. The plot follows the pattern of a steep decline in the curve from left (first component) to right (subsequent components). As a rule, when the drop in the curve almost ceases, as to make an "elbow", Cattell advises to drop all further components after the one starting the elbow. In this case, the curve creates an elbow at component 7, and thus the Cattell criterion suggests retaining eight components.

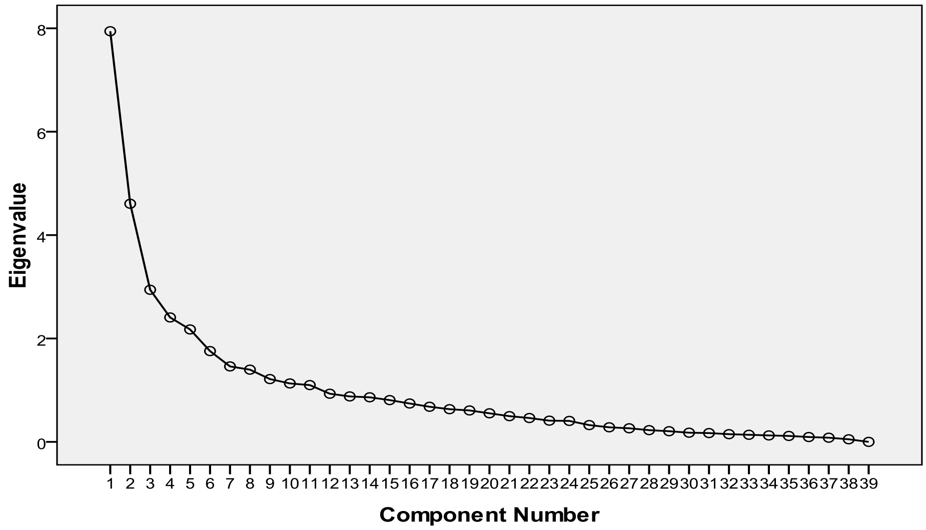


Figure 21: Scree Plot of PCA output

Although these indicators are widely recognized and valid, the final decision on the number of components to retain rests on a careful consideration of the components and their contribution to the model in terms of explanatory value. Looking at the component loadings, which relate individual variables to the individual components, the interpretability of the components is tested to see if each component and its constituting variables add to the explanatory power of a model of London town centre characteristics.

To relate the components back to the individual variables, PCA generates a correlation matrix (Table 16). This "loadings matrix" represents the correlation coefficients between variables (rows, in this case the individual variables), and the components (columns). The squared sum of loadings of a given component is equal to the variance among the variables explained by the given component.

Table 16: Component loadings matrix

Category	Variable	Components										
		1	2	3	4	5	6	7	8	9	10	11
Business	Retail	-0.85	-0.07	-0.07	-0.12	-0.03	0.23	0.11	0.16	-0.11	0.02	0.14
Workforce	Full Time Students	-0.84	-0.19	0.04	-0.04	-0.08	0.05	0.08	0.04	0.01	0.05	0.21
Workforce	Semi routine occupations	-0.80	0.32	-0.06	0.06	-0.07	-0.16	-0.22	-0.01	-0.06	-0.01	0.02
Property	Floorspace - Retail Premises	-0.65	-0.10	-0.26	-0.02	-0.32	0.06	-0.10	0.01	-0.02	-0.13	-0.23
Workforce	Higher Professional Occupations	0.62	-0.37	0.27	-0.18	-0.18	0.22	0.12	0.04	0.35	-0.03	0.17
Workforce	Large Employers & Higher Manag. Occ.	0.56	-0.14	0.47	-0.25	0.07	0.14	0.38	0.04	-0.03	0.10	0.08
Workforce	Lower Manag. & Prof. Occ.	0.53	-0.50	-0.11	0.07	-0.02	0.48	0.23	0.02	0.03	-0.18	0.00
Property	Floorspace - Offices	0.48	-0.39	0.47	-0.24	0.02	0.19	0.24	0.24	-0.11	-0.05	-0.08
Business	Professional Services	0.45	-0.35	0.02	-0.18	-0.22	0.11	0.24	0.23	-0.08	0.38	0.02
Property	RV per sqm - Offices	0.42	-0.30	0.17	-0.36	0.10	0.38	0.26	0.32	-0.06	-0.15	-0.08
Workforce	Routine Occupations	-0.18	0.81	-0.15	0.08	0.17	-0.17	-0.22	-0.13	-0.03	-0.06	-0.02
Business	Manufacturing	0.10	0.79	-0.03	-0.06	-0.02	-0.16	0.26	-0.05	-0.01	0.05	0.04
Workforce	Lower Supervisory & Techn. Occ.	-0.24	0.74	0.02	-0.09	0.27	-0.23	-0.14	0.01	-0.11	-0.13	-0.06
Business	Food and Drink	0.01	0.56	-0.21	0.05	-0.10	0.03	-0.01	-0.01	0.05	0.20	-0.10
Workforce	Intermediate Occupations	0.02	-0.23	0.83	0.02	0.04	-0.07	-0.09	-0.03	-0.06	0.04	-0.08
Workforce	Small Employers & Own Acc. Workers	-0.25	-0.05	-0.73	0.18	-0.08	-0.33	-0.14	0.01	-0.13	0.18	-0.17
Business	Ratio Employes to Workplace	0.08	-0.04	0.73	-0.15	0.29	-0.03	-0.14	-0.04	0.03	-0.15	0.03
Business	Financial Services	0.41	-0.25	0.42	-0.22	-0.28	0.08	-0.04	0.31	-0.11	0.22	0.08
Business	Charity and Voluntary	-0.03	0.02	-0.09	0.87	0.10	0.01	0.10	0.12	-0.05	-0.02	-0.10
Business	Social Work	-0.03	-0.11	-0.21	0.82	0.01	-0.04	-0.08	0.07	-0.05	0.15	-0.14
Liveability	IMD 2007 Score	0.04	0.45	0.21	0.59	0.18	0.18	-0.02	-0.04	-0.10	-0.24	0.16
Property	RV per sqm - Factories	0.07	-0.10	-0.03	0.29	0.69	-0.08	0.11	-0.11	-0.13	-0.22	0.11
Business	Transport and Logistics	0.06	0.25	0.22	-0.19	0.67	-0.08	-0.04	-0.28	-0.06	0.11	-0.18
Property	RV per sqm - Warehouse	0.06	0.01	0.31	-0.01	0.65	0.12	-0.04	0.31	0.12	-0.05	-0.04
Property	Floorspace - Warehouses	0.09	0.48	0.06	0.19	0.55	-0.05	-0.07	-0.02	0.15	0.12	0.19
Property	Floorspace - Factories	0.15	0.33	-0.13	0.28	0.46	-0.16	-0.10	-0.10	-0.13	-0.17	0.40
Business	Construction	-0.02	0.22	-0.17	-0.05	-0.01	-0.71	-0.03	0.02	-0.24	-0.09	-0.12
Property	RV per sqm - Retail Premises	0.08	-0.17	0.20	-0.40	-0.06	0.58	0.14	0.39	-0.13	-0.11	-0.07
Business	Real Estate	-0.02	-0.22	-0.32	0.05	-0.08	0.53	0.01	-0.06	-0.11	0.30	-0.10
Business	ICT	0.22	-0.11	0.01	-0.25	0.25	-0.44	0.31	0.17	0.04	0.26	0.22
Business	Creative Industries	0.08	-0.17	-0.23	0.00	0.05	0.21	0.82	0.09	-0.06	-0.01	0.06
Business	Environmental	0.12	0.05	0.07	0.06	-0.12	-0.12	0.74	-0.10	0.18	-0.17	-0.18
Business	Healthcare	0.08	-0.21	-0.12	0.04	-0.11	0.00	-0.45	-0.38	0.18	-0.38	0.28
Business	Pharmaceuticals	0.05	0.07	0.05	-0.22	0.09	0.05	0.00	-0.74	-0.07	0.11	-0.04
Business	Tourism and Leisure	-0.14	-0.14	-0.42	-0.23	0.05	0.33	0.02	0.42	-0.02	-0.09	-0.30
Business	Life Sciences	0.01	0.05	0.02	-0.08	0.05	-0.05	0.15	0.03	0.79	0.11	-0.10
Business	Higher Education & Research	0.14	-0.08	-0.04	-0.02	-0.06	0.15	-0.13	0.00	0.71	-0.28	0.08
Business	Medical Equipment	0.02	0.10	-0.11	0.07	-0.07	0.04	-0.12	-0.15	-0.05	0.66	0.00
Business	Utilities	-0.17	-0.06	0.08	-0.17	0.03	0.01	-0.09	0.01	-0.02	-0.01	0.72

For example, a component loading of 0.7 confirms that the variable is very well represented by a particular factor, given that 0.7 corresponds to about half of the variance of a variable explained by that component. The variables are ordered by the decreasing contribution to overall variability that each component makes, enabling the discovery of patterns of positive or negative loading, and correlations between variables and components that aim to model these variables. As the components are extracted by decreasing overall contribution to the variance of the dataset, latter components have increasingly weaker loadings overall. This is just another argument for the careful consideration of a sensible cut-off threshold choice. The component loadings matrix allows the interpretation of the components to make an informed final decision on the number of components to retain.

Given previous information for thresholds from the Kaiser criterion (11 components), and the Scree Plot (8 components), it is obvious that a compromise needs to be reached concerning which components to retain past component 8. Given that component 9 contains significant correlations with the life sciences and higher education industry sectors, this component potentially contains information related to clusters of biotech companies, a sector of great interest to FDI. Given these correlations, component 9 is deemed important, even though the overall contribution to the variance of all variables is small. Thus, the final choice of number of components to retain for the characterisation of London town centres is set at nine.

Table 17: Communalities between variables and components

Category	Variable	Communality
Workforce	Higher Professional Occupations	0.878
Business	Retail	0.866
Workforce	Lower Manag. & Prof. Occ.	0.863
Workforce	Small Employers & Own Acc. Workers	0.849
Workforce	Routine Occupations	0.846
Workforce	Semi routine occupations	0.834
Property	Floorspace - Offices	0.820
Business	Creative Industries	0.813
Workforce	Full Time Students	0.807
Business	Charity and Voluntary	0.806
Workforce	Large Employers & Higher Manag. Occ.	0.804
Workforce	Lower Supervisory & Techn. Occ.	0.790
Property	RV per sqm - Offices	0.786
Business	Social Work	0.781
Property	RV per sqm - Retail Premises	0.776
Workforce	Intermediate Occupations	0.767
Liveability	IMD 2007 Score	0.754
Business	Manufacturing	0.742
Business	Transport and Logistics	0.735
Business	Financial Services	0.704
Business	Environmental	0.703
Property	Floorspace - Factories	0.691
Business	Life Sciences	0.690
Business	Ratio Employes to Workplace	0.687
Property	Floorspace - Retail Premises	0.687
Business	Professional Services	0.680
Business	Healthcare	0.676
Property	RV per sqm - Factories	0.675
Business	Higher Education & Research	0.663
Business	Construction	0.663
Property	Floorspace - Warehouses	0.660
Business	Tourism and Leisure	0.658
Property	RV per sqm - Warehouse	0.657
Business	Pharmaceuticals	0.639
Business	ICT	0.615
Business	Utilities	0.588
Business	Real Estate	0.549
Business	Medical Equipment	0.505
Business	Food and Drink	0.421

As a quality control indicator, the communality table (see Table 17) lists the percentage of variance in a given variable explained by all the components jointly. Communality represents a measure of the reliability of the indicators, highlighting variables that are more or less well explained by the reduced set of components, allowing a judgement of the fit of the PCA components overall and individually.

The PCA model works less effectively for some of the smaller, underrepresented LDA target sectors, such as food and drink, medical equipment, real estate, utilities and so on. In addition, the property stock indicators for warehousing activities display lesser communalities. Although potentially the PCA can be improved by excluding variables that are only poorly represented by PCA components, a balance between explanatory power of the PCA analysis and communalities needs to be struck. The fact that industries such as food and drink or warehousing property are underrepresented may also be connected to the nature of the geographical framework, namely the town centre boundaries. T he original design of these boundaries means that industrial and commercial retail parks are not represented, which could explain why the PCA found these variables to have less communality.

Given the need to develop a geo-business classification relevant to FDI investors from a variety of sectors, there is a need to include all relevant sectors, since even those less well-represented sectors make a valuable contribution to the model and thus need to be retained.

6.2.2 Development of component profiles

The application of the PCA discussed in the previous section identified the nine most significant components. The derived components retain around 64 % of the original variance contained in the spatial database, allowing the analysis and comparison of town centres along these nine dimensions. PCA offers a link to the original variables through the component loadings and their degree of correlation, positive or negative, between a given component and a variable. To link individual town centres back to the components, individual component scores are generated for each town centre by multiplying the standardised (z-scores) variable values by the component loading value for each town centre.

For each component there is now information on which variables are most significant (loadings), and for each town centre, how representative a component is for a given variable (scores). These nine dimensions achieve the initial goal of reducing the original spatial database of variables down to a set of derived components, which highlight a variable structure allowing the construction of a town centre classification enabling a meaningful characterisation and comparison between FDI location options.

Without the information on components' variable loadings, component scores for each town centre are meaningless, as they represent to a variable degree (according to the individual loadings) a set of original variables. To make the results of the PCA analysis accessible to end users, and as a visualisation and exploration tool, PCA component profiles are developed. These profiles describe, quantify, and qualify each component according to the most significantly loaded variables (positively or negatively correlated), attached to each component. Each profile is a comprehensive account of the variables that make the component distinctive.

The information contained in these profiles allows the understanding of the main component characteristics, and distinction from other components, as defined by the most significant variables in the original spatial database. Through the component scores, town centre rankings for each component are also computed, indicating how representative of a given component each town centre is. Component profiles contain the following elements:

1. **Most positively/negatively correlated variables:** From the component loadings, the most significantly loaded variables can be identified. The identification of both the strength and direction of correlation enables the development of an understanding of what aspect of a town centre the component represents.
2. **Component name/label**: A short, memorable, and distinctive component name allows the classification user to grasp the overall thrust of what a town centre component signifies in terms of economic activity, liveability, socioeconomic makeup of the workforce, and property stock. Although a challenge to summarise in a couple of words the meaning of such a varied set of variables, the naming process is essential to aid exploration and understanding of components and their meaning.
3. **Keywords**: Using the component loadings, an expanded narrative description of representative characteristics is developed, in terms of the business environment, quality of the workforce, property prices, and characteristics, as well as the general living environment.
4. **Most/least representative town centres:** Through the component scores, a ranked list allows the identification of the most "typical" or "atypical" town centres.
5. **Example street views of the most/least representative town centres:** From the list of most representative town centres, as well as from the list of correlated location variables, a pictorial narrative is developed, showing typical businesses an investor

would be likely to encounter in town centres typical of a given component, as well as street views, shops, and other pictures giving a general context of the town centre profile.

The following section presents the profiles of these nine components, in order of decreasing contribution to the overall variance of the spatial database:

1. “Urban Professionals”
2. “Blue Collar Industry”
3. “Blue Chip Finance”
4. “Third Sector Centres”
5. “Big Sheds and Trucks”
6. “High (End) Streets”
7. “Creative and Green Minds”
8. “Sights of London”
9. “Ivory Towers”

These profiles are constructed from the component loadings, in other words, the variables which are either positively or negatively correlated with the components. These profiles form the final geo-business classification retained to support FDI location decision-making. Apart from the profile components listed previously, each profile also contains an overview map highlighting the component scores, from -2, or least representative, to +2, most representative.

6.2.2.1 Urban professionals

The first PCA component accounts for the largest percentage of variance of all variables, around 11 % of the underlying data variables. As such, this component plays an important role in the characterisation of London town centres. From the geographic distribution of the component and correlated variables, this component characterises typical Central London activities in the knowledge and professional services industry, from big accountancy and professional services firms to major financial institutions. The concentration of these sectors representative of the knowledge economy is also reflected in an above-average concentration of a highly skilled workforce, mainly composed of skilled professionals and managers (see Figure 22).

Given the nature of the employment opportunities, there are not many lower skilled work opportunities or full-time students. The property stock is mainly composed of high-quality office space and limited retail space. The most representative town centres for this component thus make up the City of London's global financial centre, Canary Wharf, and Holborn in Central London. The least representative town centres are found in outer London areas such as Brent Cross (a major shopping centre), Hendon, and Bexleyheath (see Figure 23).

Urban professionals

Keywords:
Professional and financial service economy, mix of large & small employers, skilled managerial and professional employees, land use predominantly high quality offices, limited retail space,

Most representative

1. Cheapside
2. Leadenhall
3. Liverpool Street and Bishopsgate
4. Holborn
5. Canary Wharf

Least representative

1. Brent Cross
2. Hendon Central
3. Bexleyheath
4. Chingford Mount
5. Hornchurch

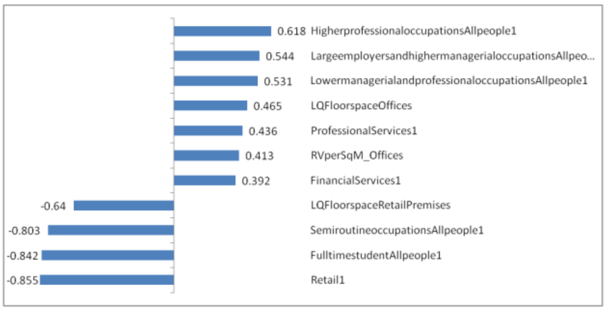


Figure 22: Profile of "Urban Professionals" [38]

[38] Images taken from Flickr website (http://www.flickr.com/).

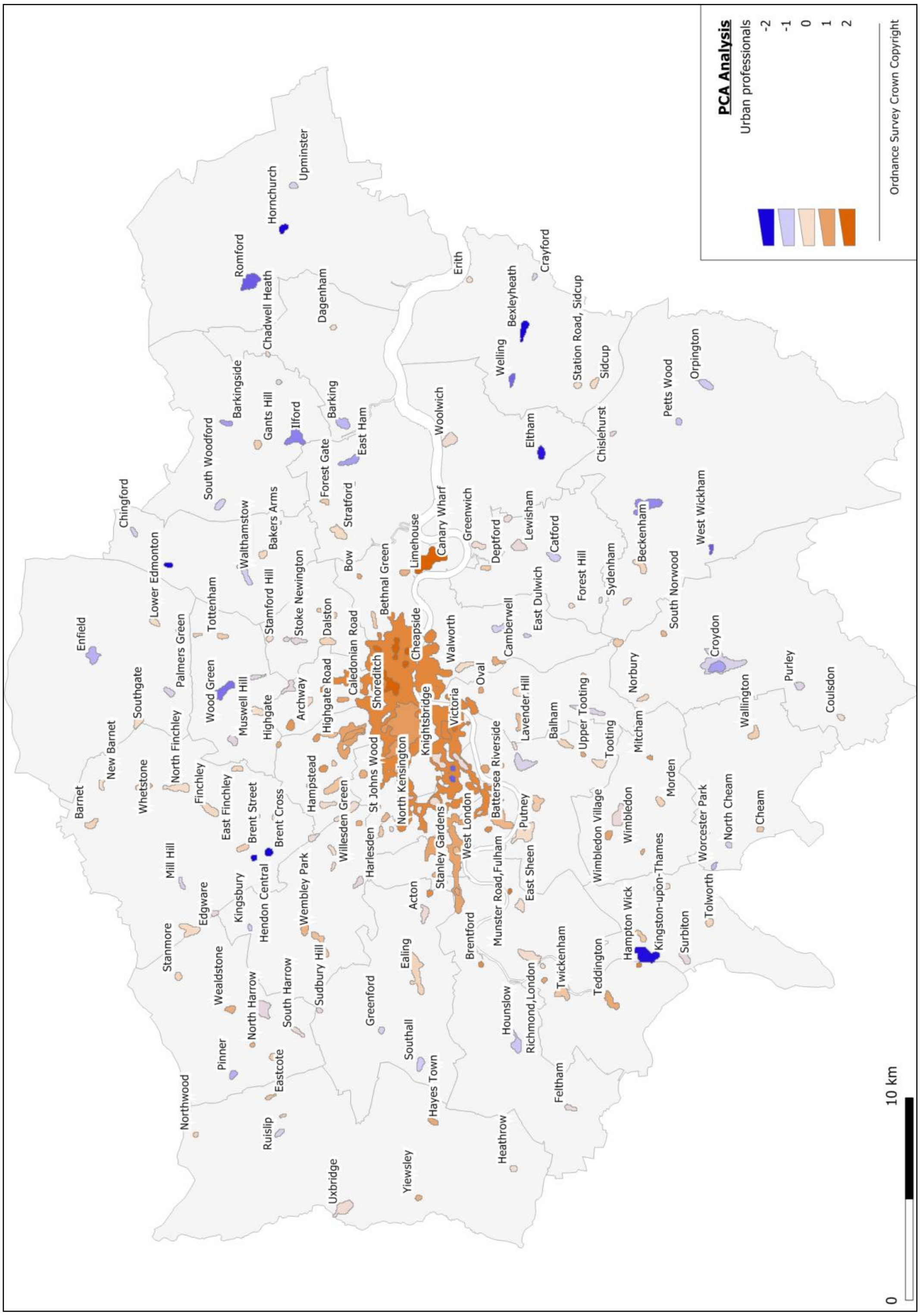


Figure 23: Map of “Urban Professionals”

6.2.2.2 *Blue collar industry*

The "Blue Collar Industry" component is the second component of the PCA analysis, and accounts for around 10% of the global data variance. Given the nature of the PCA analysis, the components created are, by definition, generated as uncorrelated (orthogonal) to other components. The second component thus represents the "opposite" of the "Urban Professionals" professional and financial services economy. The "Blue Collar Industry" component has an industrial sector makeup mainly concerned with manufacturing activities, including the food and drink industry. Logistics and distribution do not make a highly significant contribution to the component characterisation (at a factor loading of 0.25). Given the industry sectors, the workforce is mainly composed of supervisory, routine, and technical employees, of a comparatively low-skilled nature. The property stock is characterised by an abundance of warehousing, with a relative scarcity of office space (see Figure 24).

The geographic distribution of the most representative town centres identifies Dagenham, famous for its manufacturing tradition in the automotive sector, such as the Ford motor factory, but also locations outside Central London in the East and North of London, such as Bow, Tottenham, Edmonton, and Kenton in Harrow (see Figure 25).

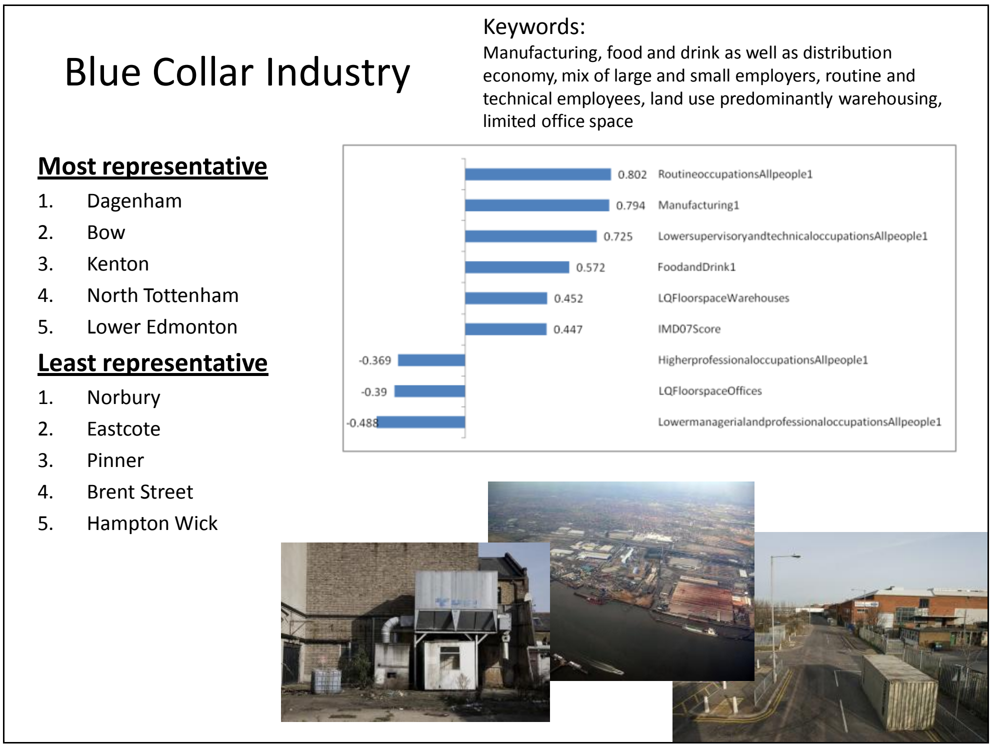


Figure 24: Profile of "Blue Collar Industry"[39]

[39] Images taken from Flickr website (http://www.flickr.com/).

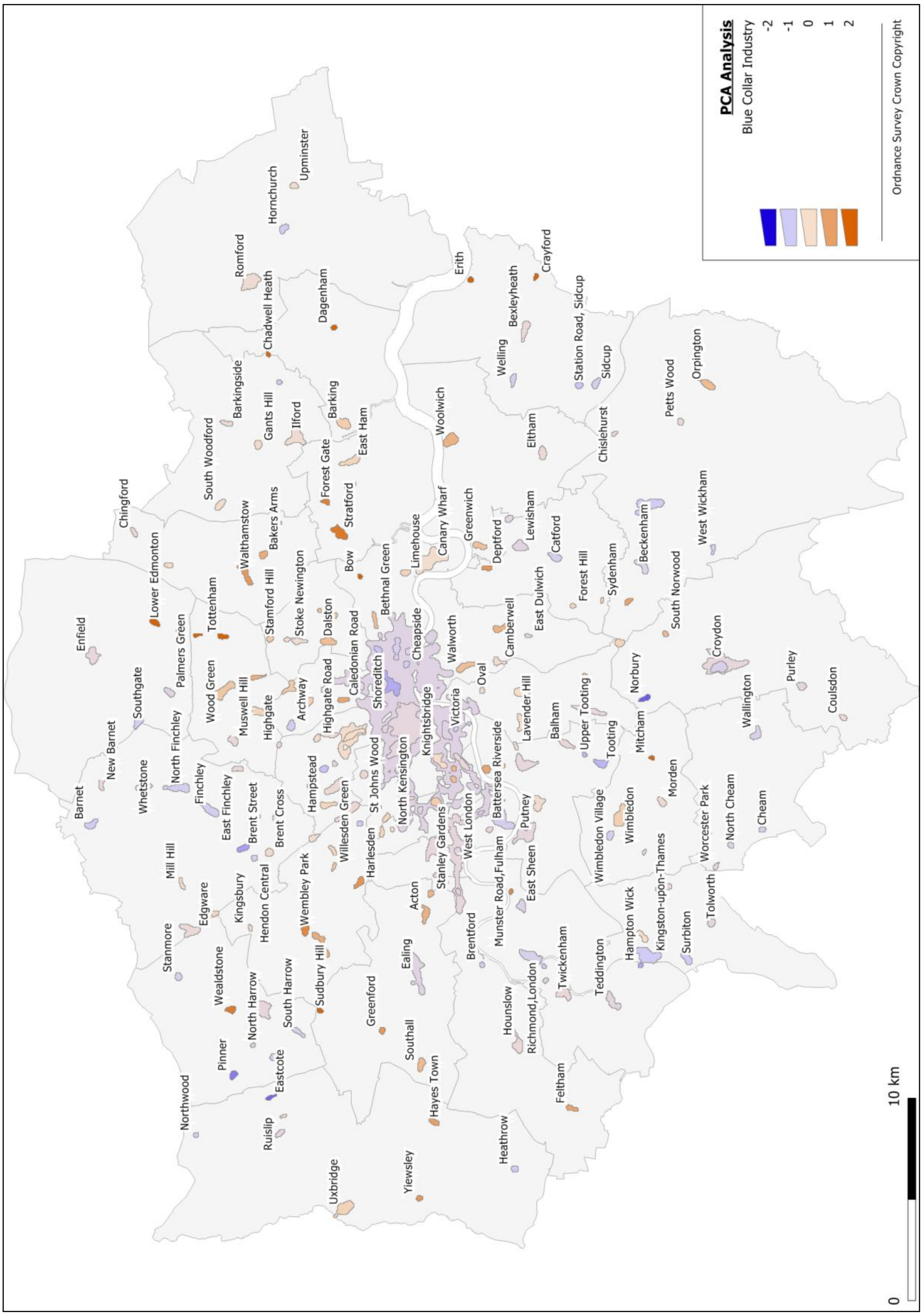


Figure 25: Map of “Blue Collar Industry”

6.2.2.3 Blue chip finance

"Blue Chip Finance", accounts for around 8% of total variance. The component presents similar characteristics to "Urban Professionals" nevertheless there are differences. There is a significant correlation with the presence of larger firms, which is not the case for "Urban Professionals". Financial services are significantly positively correlated, but not professional services (loading of 0.02). The workforce qualification level is lower than for "Urban Professionals", with intermediate occupations as the most highly correlated (0.83) group, followed by skilled managerial and professional occupations, and a comparative lack of self-employed and small employers (see Figure 26).

The City of London town centre and Canary Wharf score highly, although it is worth noting that Croydon Retail Core comes in fourth. This component is representative of the back office functions of larger organisations, such as financial institutions, in slightly "cheaper" locations such as Canary Wharf or Croydon. This observation is also reinforced by a negative correlation with tourism and leisure industry (-0.42), which is mostly located in Central London locations. In contrast, the *upmarket* "Urban Professionals" component is representative of organisations' front offices, such as headquarters, along with the co-location of large professional services firms in first-rate Central London locations (see Figure 27).

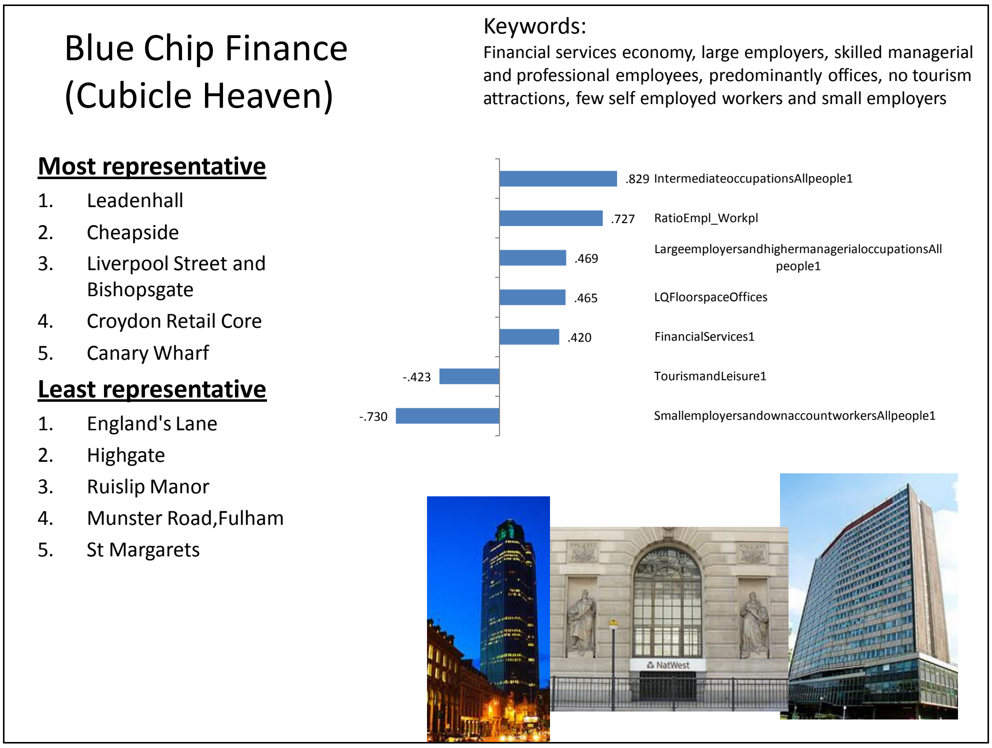


Figure 26: Profile of "Blue Chip Finance"[40]

[40] Images taken from Flickr website (http://www.flickr.com/).

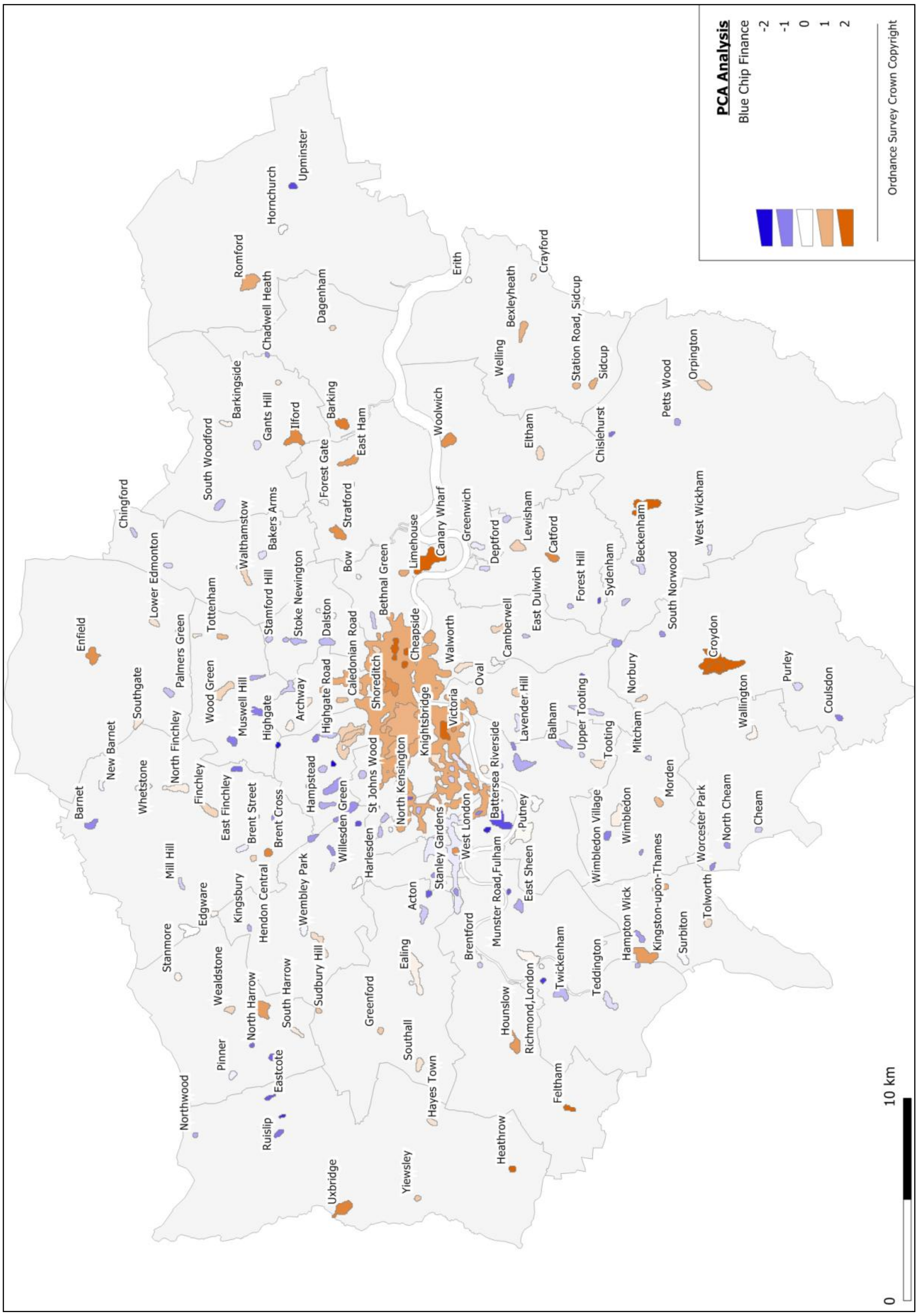


Figure 27: Map of "Blue Chip Finance"

6.2.2.4 Third sector centres

Given the orthogonal nature of the components, the next component has very different characteristics to the “Blue Chip Finance” component. This component accounts for about 7% of the variance.

The “Third sector Centres” component is characterised by the presence of charity and voluntary, as well as social work industry sectors. Together with the association to high IMD scores, the dimension characterised by this component is one of deprived areas, with sparse local work opportunities apart from social work and third-sector charity work, often on a voluntary basis. Although there is retail activity, the property stock is of low value and quality, with some small offices, again of low quality. There is evidence of some factory stock (see Figure 29).

The geographic distribution of the most representative “Third Sector Centres” is composed mainly of deprived inner and outer London town centres, such as North Kensington, Brixton, Norbury, and Maida Hill (see Figure 28). It is interesting to note that some North and South Kensington areas seem to be diametrically opposed in this component, North Kensington being one of the most representative town centres, versus South Kensington, one of the least representative areas. Deprivation plays an important role in the characterisation of this component, and steep social gradients between neighbouring areas of London explain these extreme contrasts, an issue explored in more detail in Harris & Longley (2002).

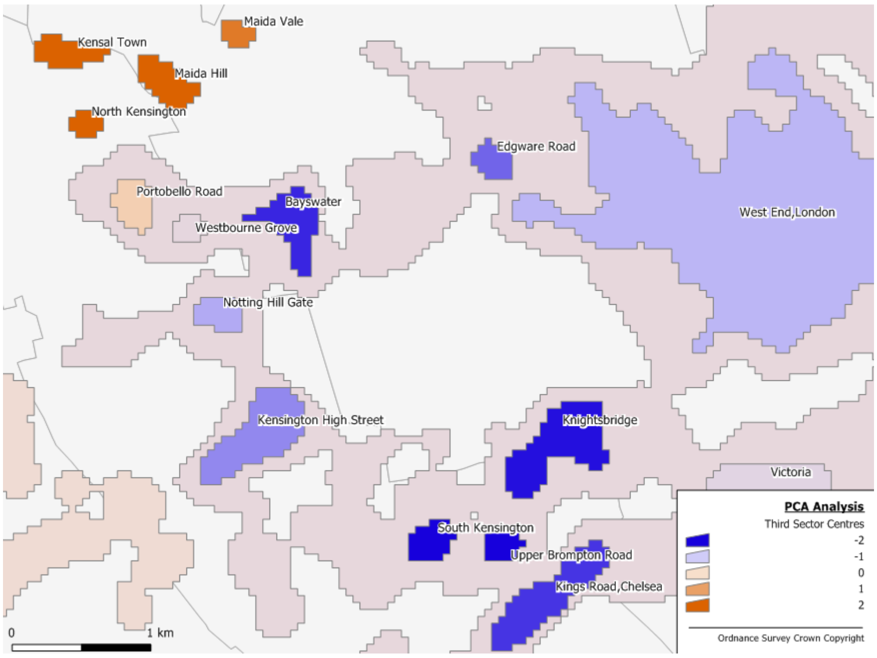


Figure 28: “Third Sector Centres” in West London

Third Sector Centres

Keywords:
Third sector and caring professionals, deprived neighbourhoods, low value/quality retail and office premises

Most representative

1. Norbury
2. North Kensington
3. Brixton
4. Kensal Town
5. Maida Hill

Least representative

1. Upper Brompton Road
2. Heathrow
3. South Kensington
4. Yiewsley
5. Knightsbridge

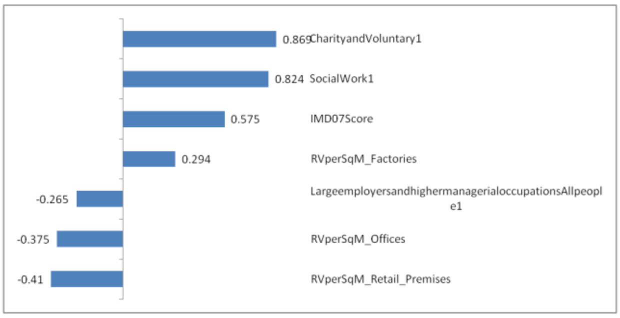


Figure 29: Profile of “Third Sector Centres”[41]

[41] Images taken from Flickr website (http://www.flickr.com/).

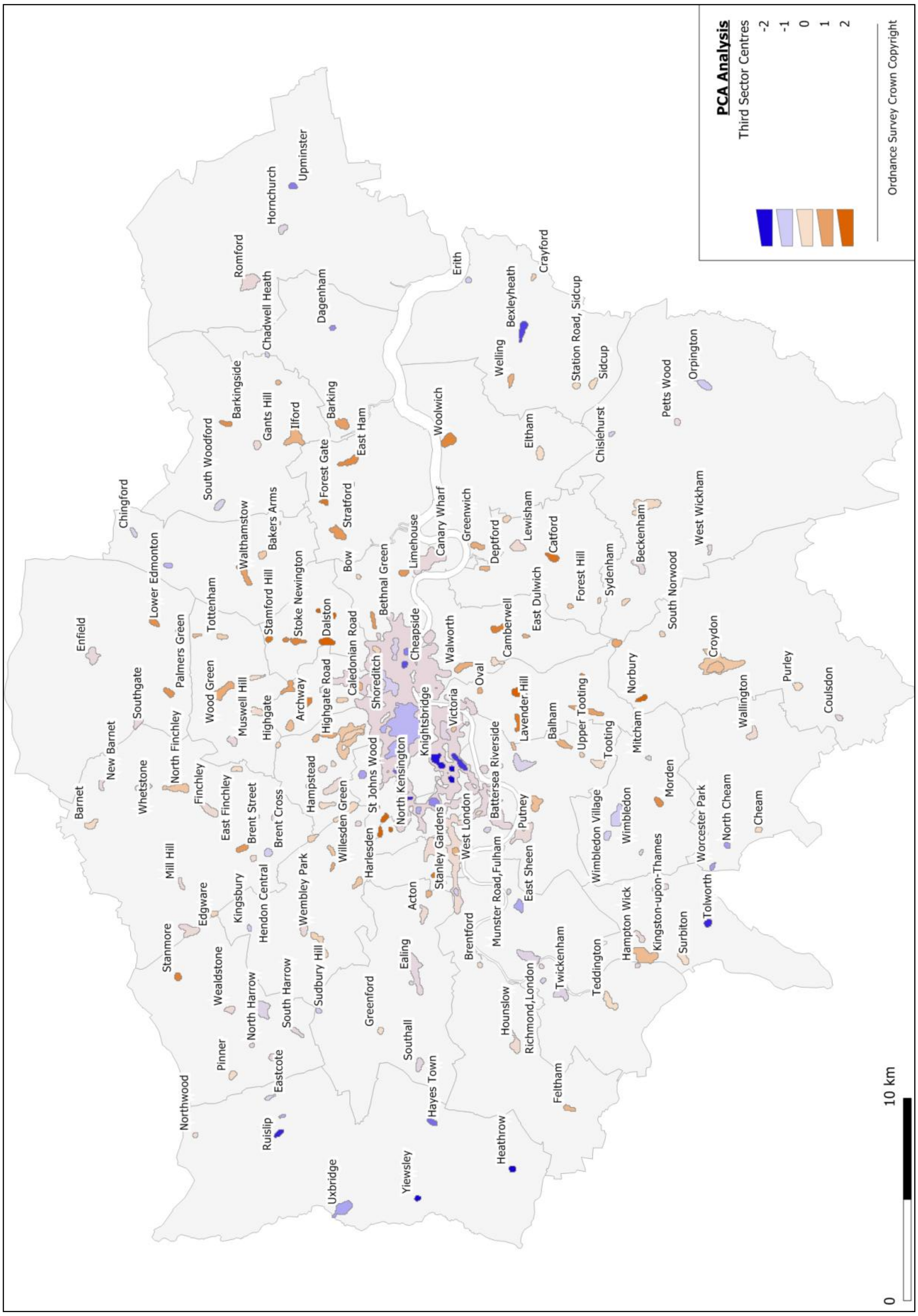


Figure 30: Map of “Third Sector Centres”

6.2.2.5 Big sheds and trucks

The fifth component is mainly characterised by a warehousing and distribution economy, contributing about 6% of total variance.

"Big Sheds and Trucks" is marked by a significantly above average concentration of transport and logistics businesses. The property stock is composed mainly of both warehousing and factories, both above average in quantity as well as quality, according to the rateable value indicators. The workforce is mainly comprised of lower skilled workers. There is a clear negative correlation with financial service businesses (see Figure 31).

Given this clear orientation towards transport and logistics, the most representative town centres are in West London, focused around Heathrow as one of the most important international transportation hubs of London and the UK (see Figure 32).

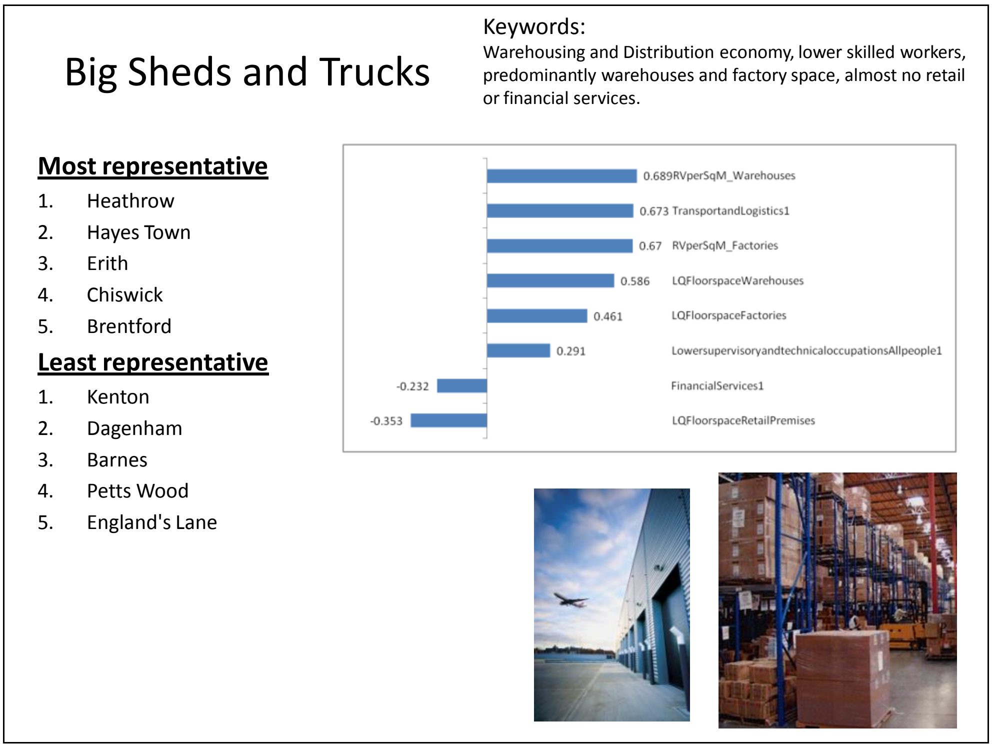


Figure 31: Profile of "Big Sheds and Trucks"[42]

[42] Images taken from Flickr website (http://www.flickr.com/).

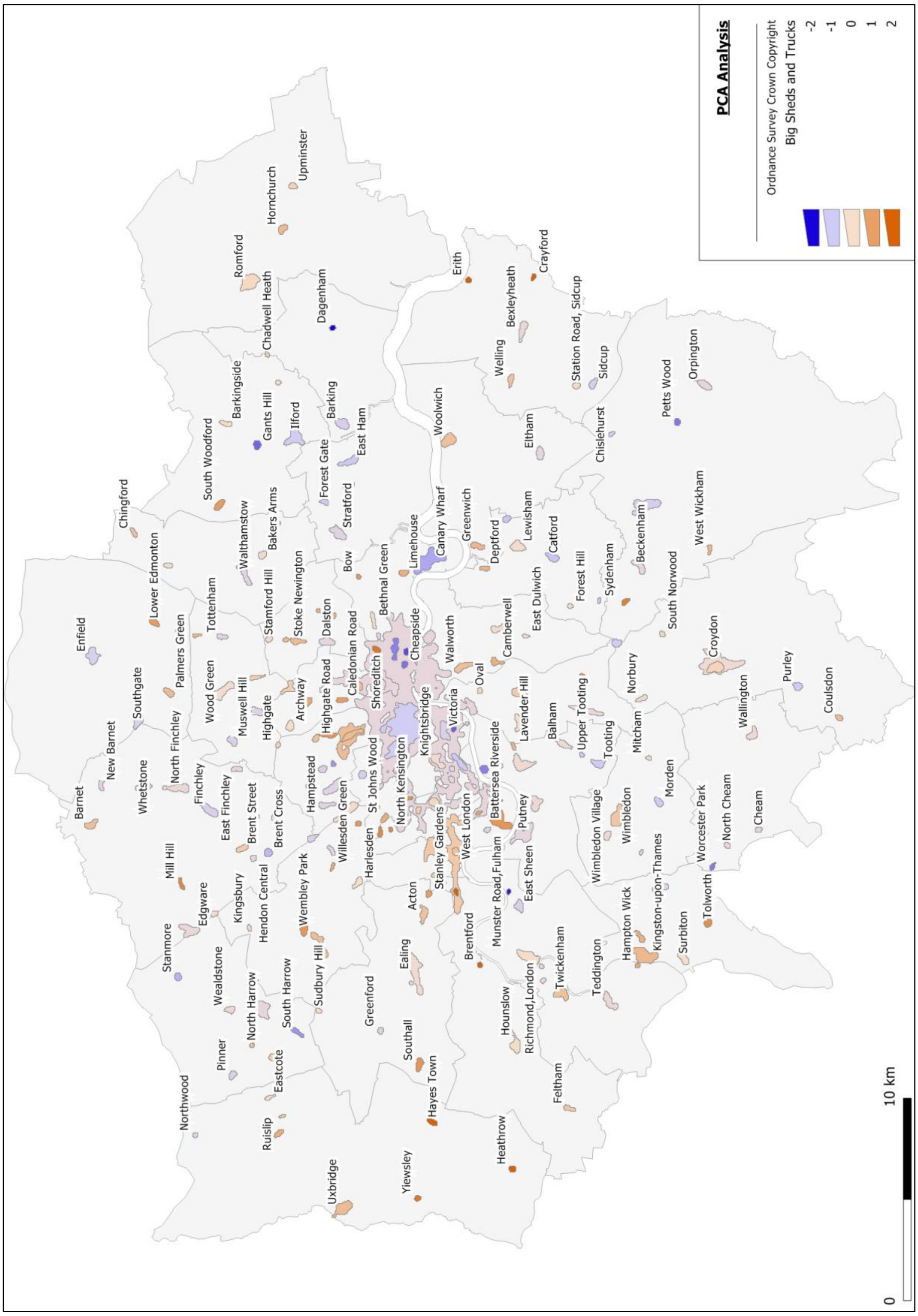


Figure 32: Map of "Big Sheds and Trucks"

6.2.2.6 High (end) streets

The sixth component accounts for 6% of variance. The label of the sector, "High (End) Streets", is deduced from the concentration of correlated variables related to high-end retail sector activities, including the real estate industry. High quality retail and office premises are significantly correlated, along with a workforce comprised mainly of lower managerial and professional occupations. This component is also marked by the lack of Information and Communication Technologies (ICT) and construction companies. It is interesting to note that there is only a weak correlation with the IMD (0.18) in this component (see Figure 33).

The geographical distribution of the component scores shows that the most typical "High (End) Streets" town centres are located in West London, with town centres such as Upper Brompton Road and South Kensington being the most representative. The least representative are town centres located further away from Central London, in less well off areas such as Mitcham, Eastcote, and South Harrow (see Figure 34).

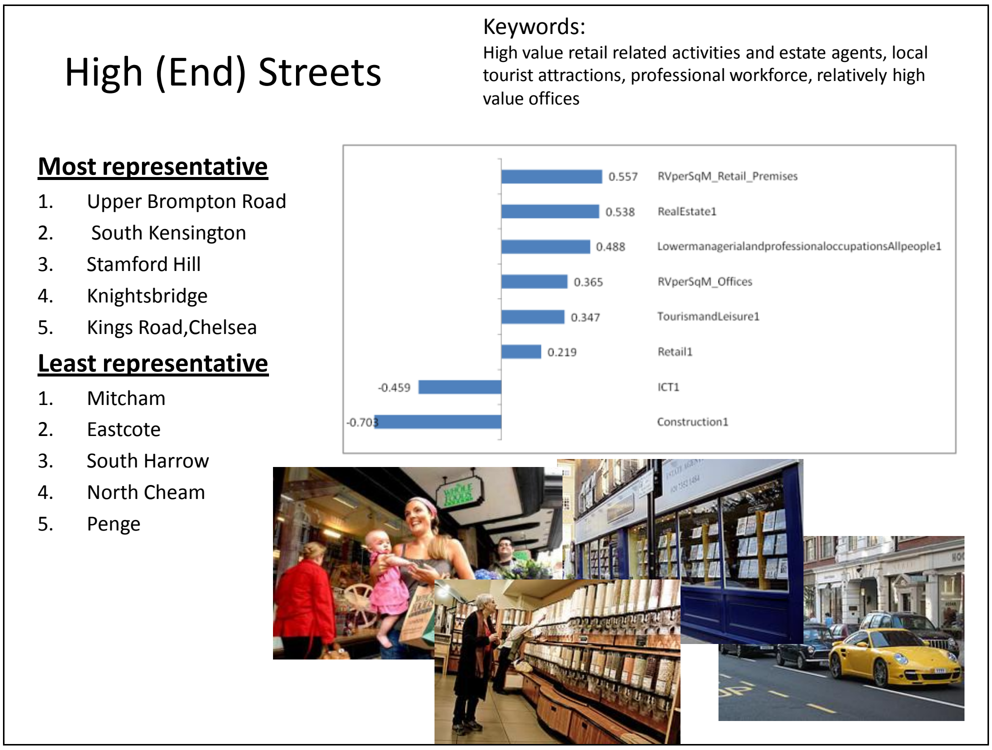


Figure 33: Profile of "High End Streets"[43]

[43] Images taken from Flickr website (http://www.flickr.com/).

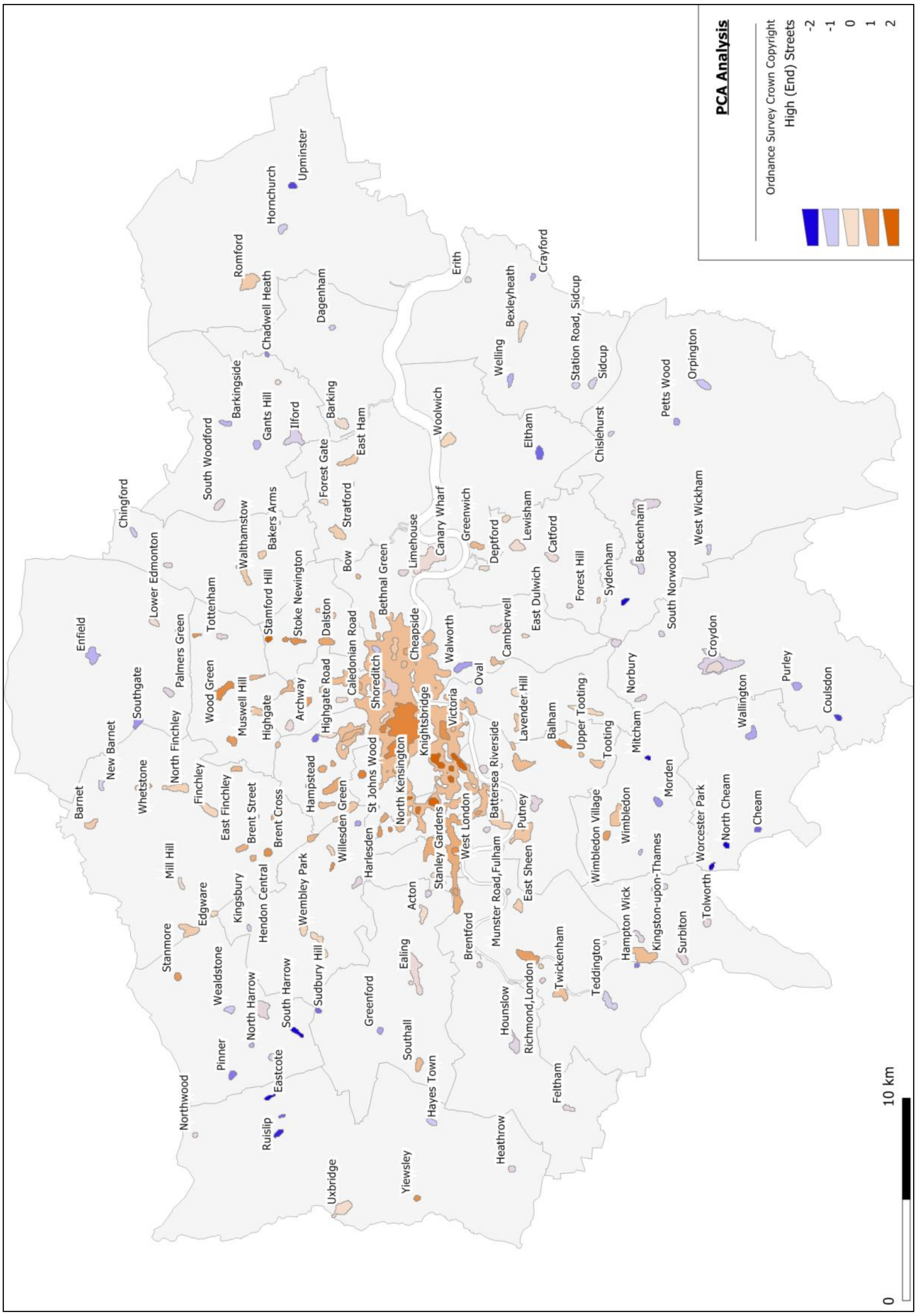


Figure 34: Map of "High End Streets"

6.2.2.7 Creative & green minds

The seventh component accounts for another 6% of total variance. The significantly correlated variables are businesses in the creative, environmental, and ICT sectors. A weak correlation with the professional services sector is noted (0.24), as well as manufacturing (0.26). There also is a significant negative correlation with the healthcare sector. The most significant correlations represent an economy dominated by creative sector and environmental consultancy-type businesses with a highly skilled workforce. The label "Creative & Green Minds" is chosen to express this interpretation. The workforce is composed of highly qualified managers working for larger employers, as well as professionals, with a negative correlation for routine and semi-routine occupations. Regarding the property stock, there is a weak positive correlation towards higher quality offices (see Figure 35). The geographic distribution of the component highlights representative areas in West London, such as Battersea and Hammersmith, as well as north of Central London Camden (including Kentish Town). Least representative is Heathrow and Camberwell, as well as East London (Seven Kings). Leadenhall in the City of London is one of the least representative areas for this component, along with the City of London and Canary Wharf town centres (see Figure 36).

Creative & Green Minds

Keywords:
Predominantly creative industry, ICT and environmental industry, large employers, few manual labour workforce

Most representative

1. Battersea Riverside
2. Hammersmith
3. Camden High Street
4. Latchmere Road,Battersea
5. Kentish Town

Least representative

1. Heathrow
2. Camberwell
3. Seven Kings
4. Upper Tooting
5. Leadenhall

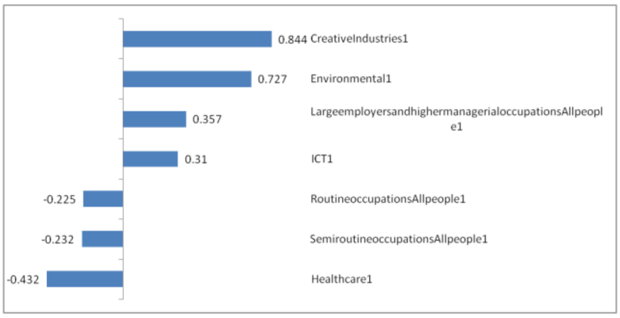


Figure 35: Profile of "Creative and Green Minds"[44]

[44] Images taken from Flickr website (http://www.flickr.com/).

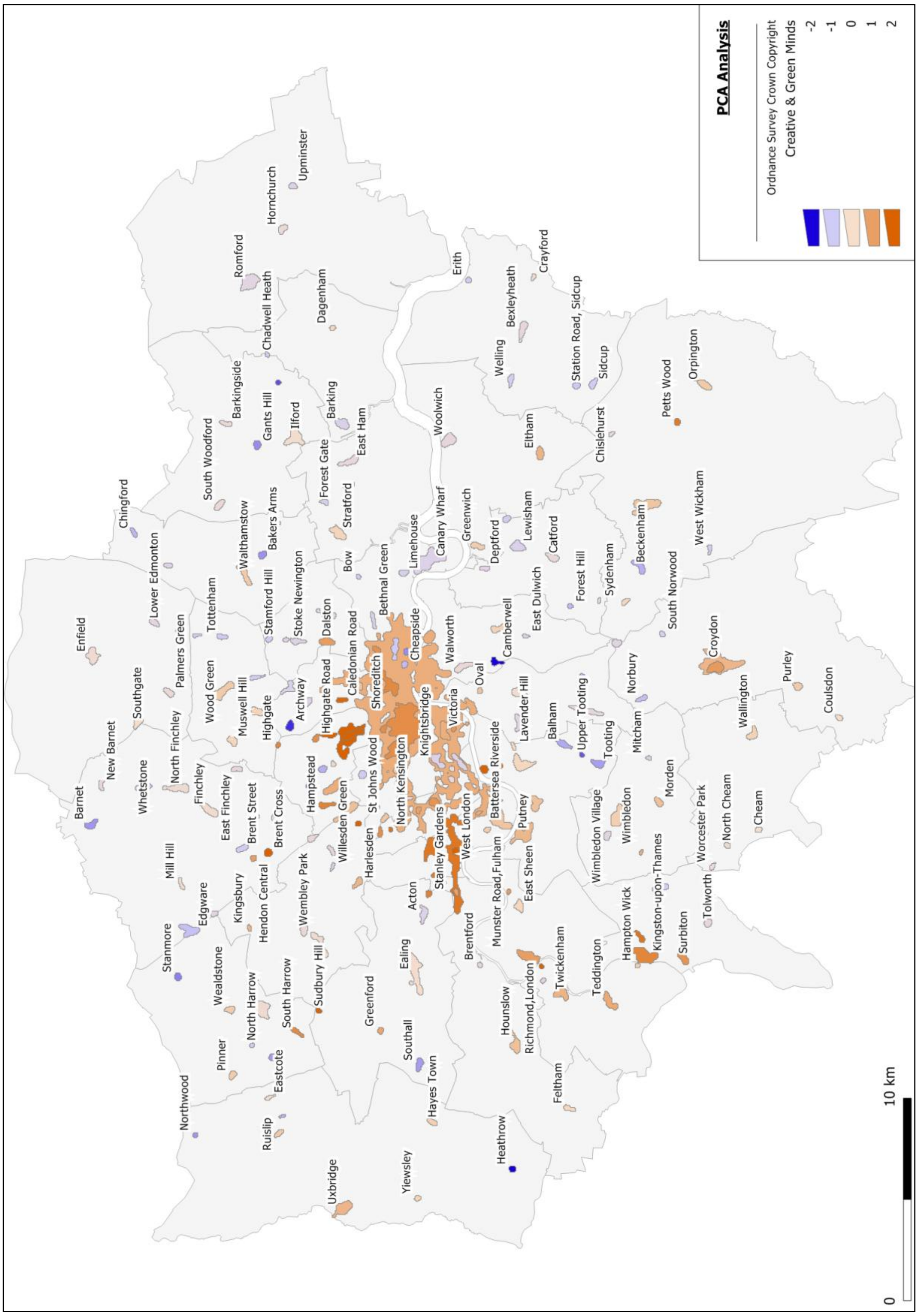


Figure 36: Map of “Creative and Green Minds”

6.2.2.8 Sights of London

“Sights of London” is named after the concentration of both tourism and leisure related activities, as well as retail activities, together with significant correlations with a property stock of high value offices. Geographically, these conditions are found mostly in Central and West London, the retail areas that also are the main hubs of tourism activity. There are significant negative correlations with the pharmaceutical and healthcare industries, as well as with transport and logistics (see Figure 37).

The most representative town centres are Bayswater, Cheapside, Leadenhall, Liverpool and Bishopsgate in the City of London, along with areas in West London, such as Knightsbridge (see Figure 38).

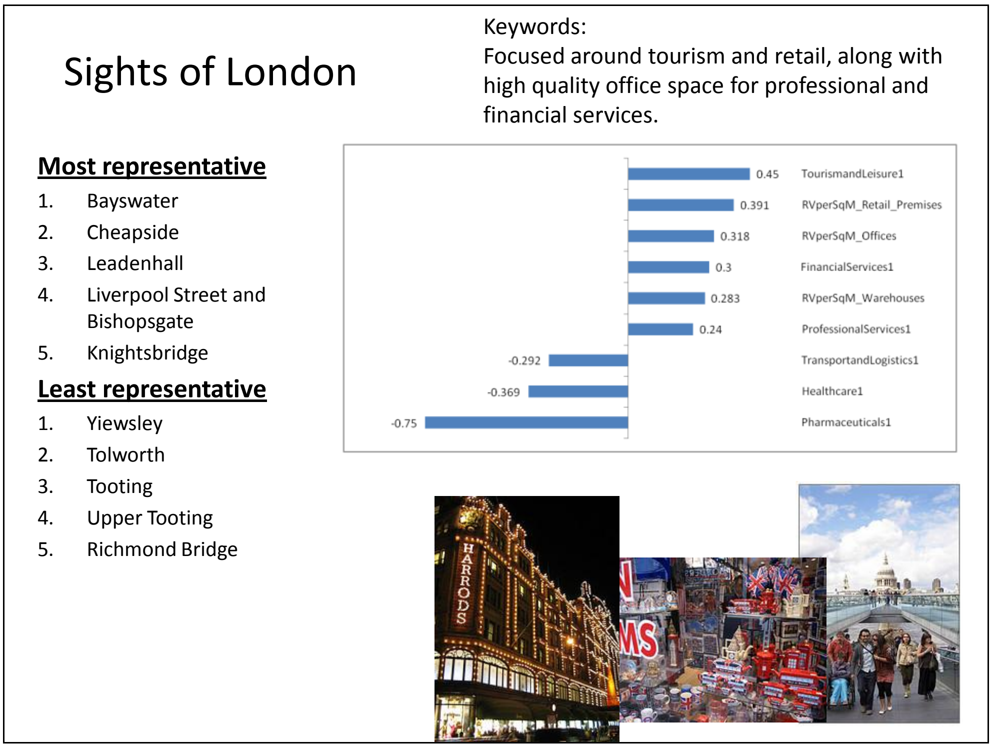


Figure 37: Profile of “Sights of London”[45]

[45] Images taken from Flickr website (http://www.flickr.com/).

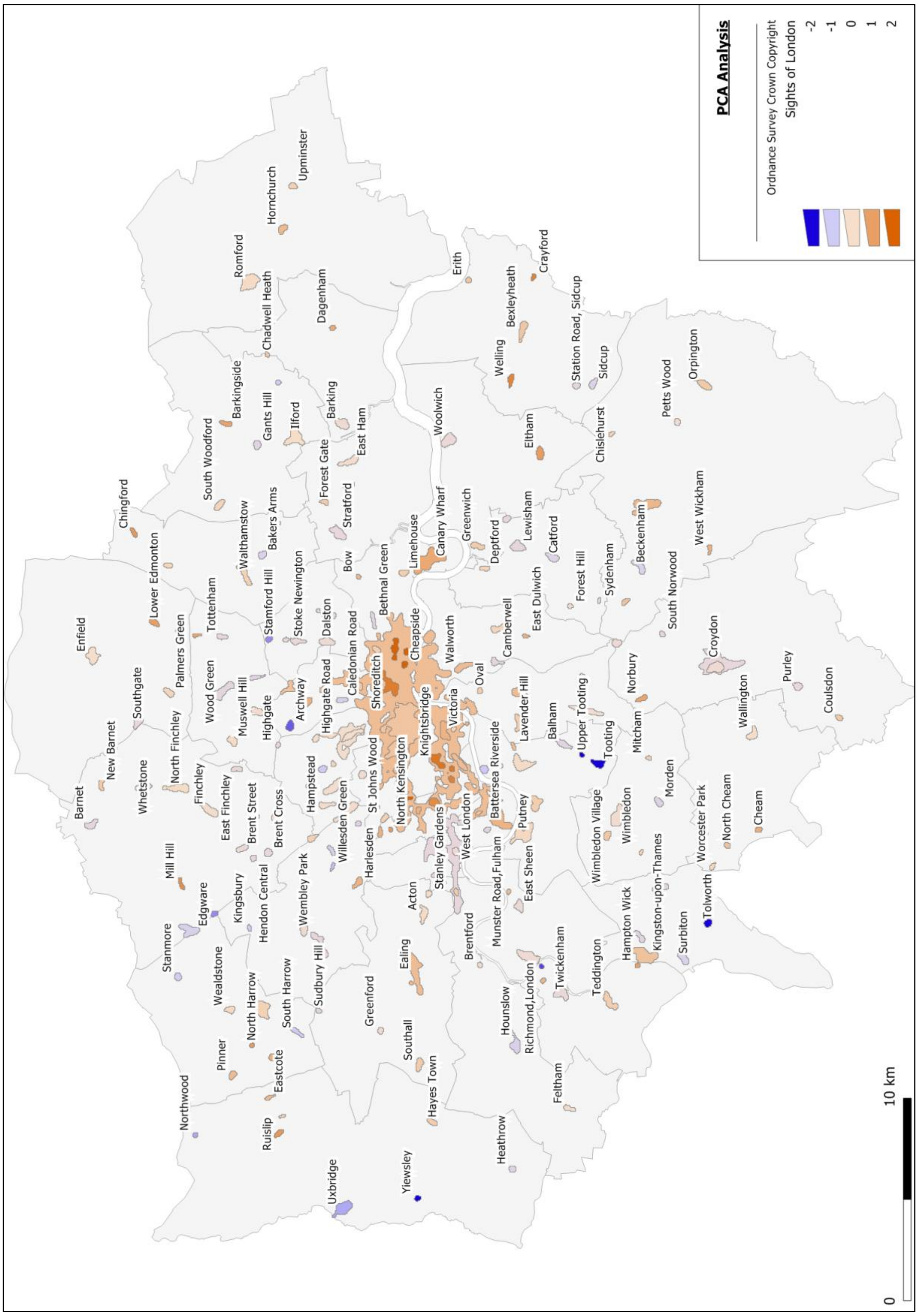


Figure 38: Map of “Sights of London”

6.2.2.9 Ivory towers

The ninth and final component is included in the analysis, even though the previous Scree Plot criterion results excluded the component from the final analysis output. Given the aforementioned limitations of these threshold criteria, a subjective appreciation of the significance of the component is advised. Given the significant correlation of this component with life sciences industries and higher education institutions, the component is deemed useful to FDI promotion, and is therefore included in the final geo-business component set. Apart from these two significant sectors, the workforce is qualified as higher professional occupations. Given this combination of significant variables, it makes sense to relate this component to a dimension of co-location of universities and life science firms, possibly university spinouts (see Figure 39).

Due to the narrow definition of the component, the geographical distribution of the component scores highlights individual town centres where significant life sciences companies are located (see Figure 40). This is the case, for example, in Mill Hill, which hosts the National Centre for Medical Research, the largest medical research centre in the UK.

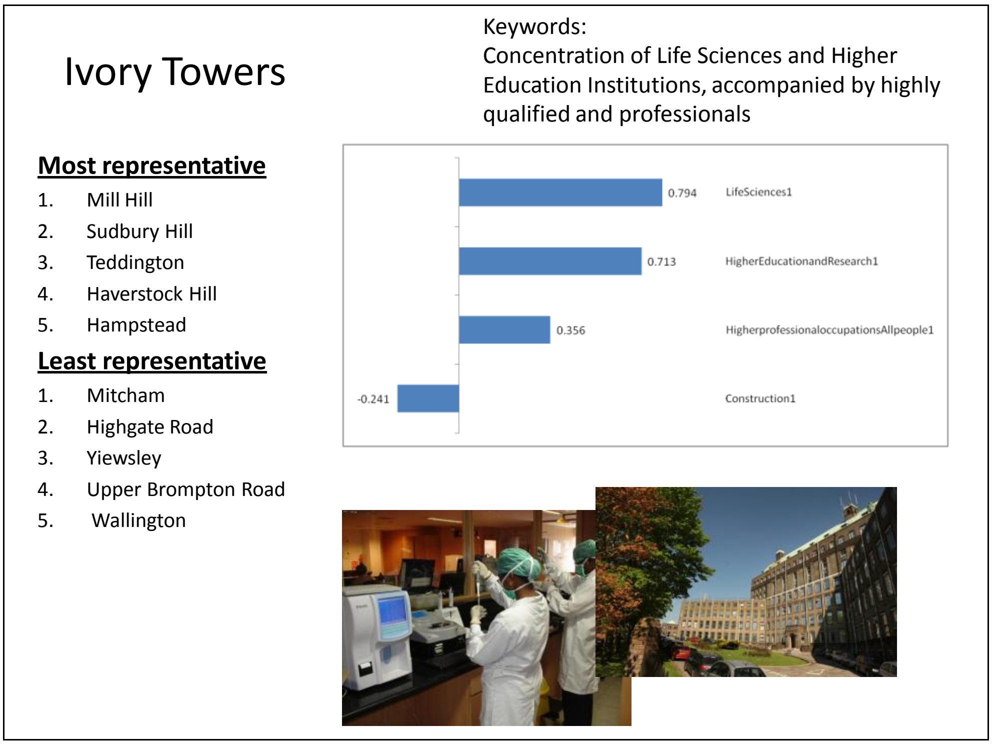


Figure 39: Profile of "Ivory Towers"[46]

[46] Images taken from Flickr website (http://www.flickr.com/).

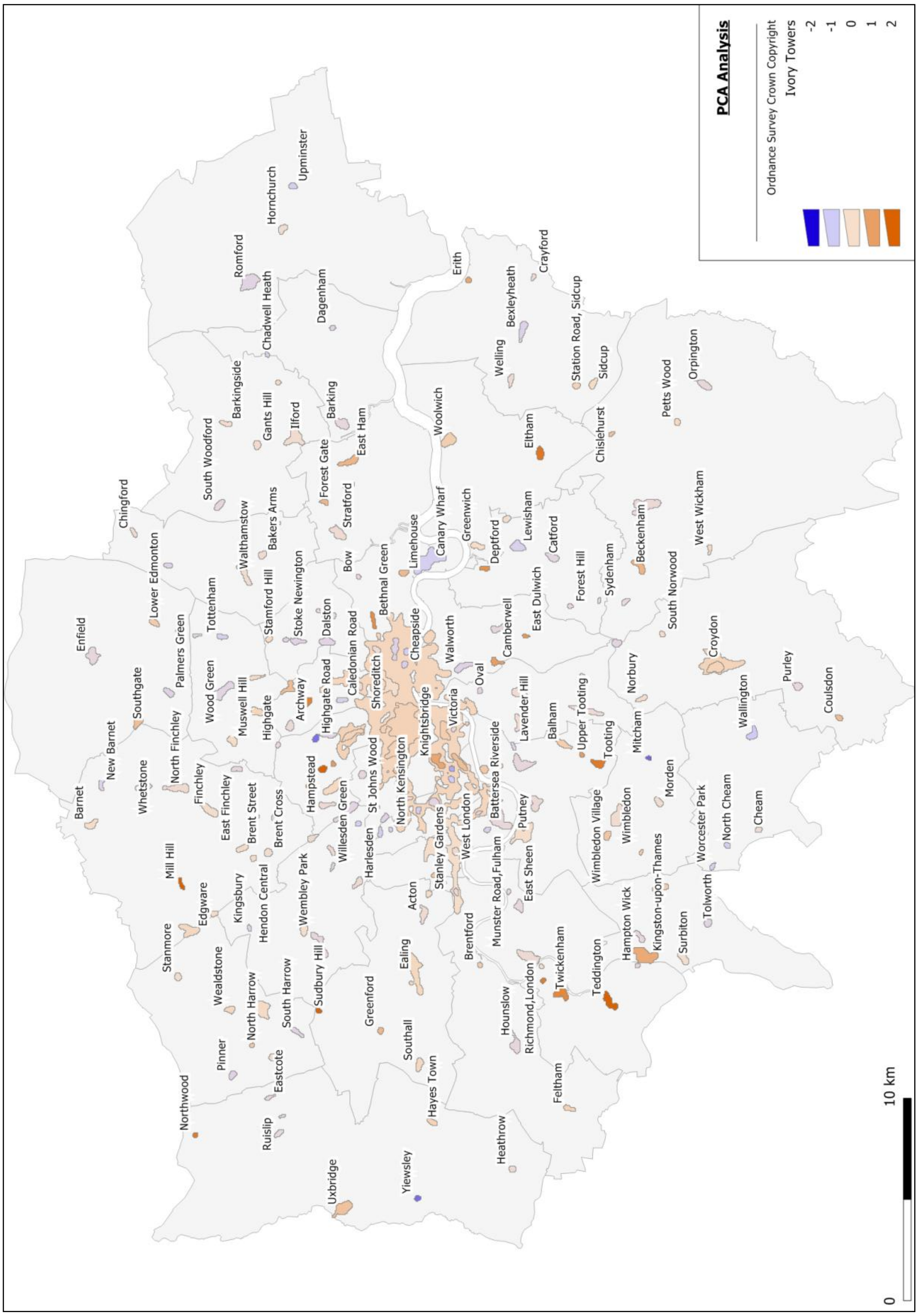


Figure 40: Map of “Ivory Towers”

6.3 Discussion

Looking back at the process formulated for the development of the geo-business classification, PCA offers a methodology to derive, from an initial database of around fifty FDI relevant location variables, the most important data dimensions, expressed as nine new variables called components. The components are linked back to the original variables through component loadings (correlations), allowing the analysis and comparison of town centres along these nine dimensions. The components are characterised through the development of component profiles and linked back to the town centres through the component scores (see Figure 41 for a summary diagram of the process).

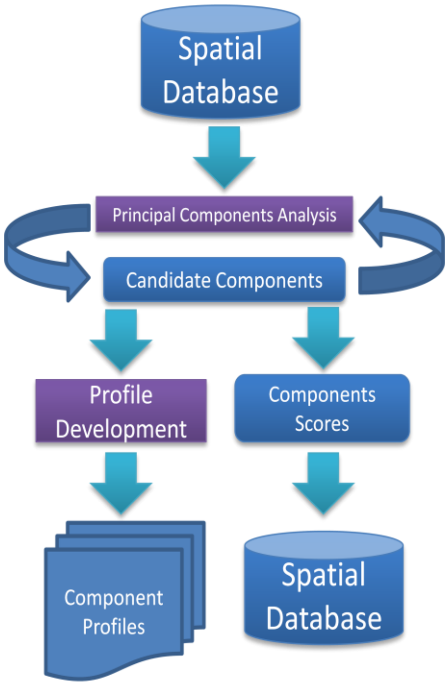


Figure 41: Diagram of the construction of the component profiles

Individual components are “brought to life” through profiles that describe, quantify, and qualify the most significant variables attached to each component, creating a comprehensive account of the distinctive features. Each profile includes a short, distinctive component label, a list of the most significantly positively or negatively correlated variables, a short narrative description of distinctive characteristics, a ranked list of the most or least representative town centres, and some representative street views.

For the understanding of the nature of an individual town centre according to its component scores, it is important to note that the component profiles are not mutually exclusive. One town centre is composed of several components in varying degrees, reflected by the component scores. This is the case for all town centres across London, even though for some town centres, one component will be clearly dominant relative to others (see Dagenham, for example, in Figure 42).

The visualisation of the component scores allows both the comparison of the nine component scores for a single town centre and the comparison between town centres, i.e. both intra-and inter-comparison of component scores, with each radial axis representing one PCA component score. Several town centre component scores can be plotted on the same diagram, making possible the comparison of profiles for different town centres.

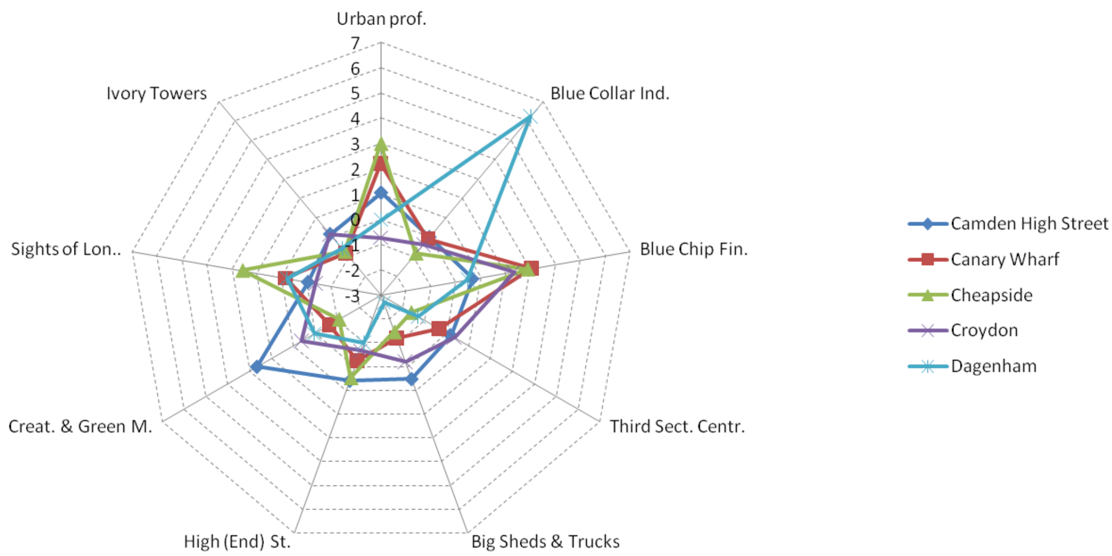


Figure 42: Factor loadings radar plot for five town centres

For example, when comparing Canary Wharf and Cheapside (red squares and green triangles in Figure 42), both town centres have significant component scores for both “Urban Professionals” and “Blue Chip Finance”. Both town centres seem to be quite similar in terms of their component scores, although Cheapside scores higher on the “Sights of London” component. On the other hand, Dagenham is almost exclusively characterised by “Blue Collar Industry”.

These nine components and their attached descriptions achieve the goal of this thesis to describe and distinguish different areas of London's complex business landscape, albeit in a reductionist manner, by both reducing the spatial and attribute complexity through aggregation and summarisation. However, this geo-business classification presents a number of constraints and limitations. These can be classified as: inherent limitations attached to the constituent datasets acting as proxy for the relevant location variables identified, the limitations of the chosen geographic framework, and the methodology, which generated the components constituting the final geo-business classification.

6.3.1 Limitations of existing spatial data framework

The geo-business classification developed as the basis for the characterisation of town centres across London is limited by the constituent datasets, as well as by the spatial boundaries that delineate these neighbourhoods. The integration of different spatial datasets, at varying spatial scales and aggregation levels, also poses challenges given the need for detailed localised statistics relevant to the spatial scale of London's town centres, along with integration and standardisation issues for the development of compound indicators. The procurement and licensing of some of these external datasets that act as explanatory proxies for relevant location variables has been one of the most challenging and time-consuming aspects of building a complete and relevant database.

The next section discusses some of the problems encountered, including the qualification of functional versus industry sectors and the lack of good quality data sources, as well as the procurement of relevant, complete, and detailed datasets regarding measures of public transport accessibility and travel times between locations.

6.3.1.1 Capturing functional industry characteristics

While relevant datasets for the main location variables were found, there is a need to discuss some of the compromises and shortcomings of the resulting spatial database. In the context of the post-industrial knowledge economy, which represents the business landscape in London today, the lack of suitable indicators capable of capturing the intricacies of this new knowledge economy becomes apparent. As (Godin 2006) points out:

> *"there are no purpose designed and sound indicators, nor methodologies for the measurement of the new knowledge economy and innovation systems. To date*

the concept of a knowledge based economy has had a very limited impact on statistics".

Some of the difficulties distinguishing knowledge-intensive activities become apparent when trying to identify areas, which present R&D centres of activities, in sectors such as pharmaceutical and life sciences. In the case of the pharmaceutical industry, the distinction between R&D centres, which represent concentrations of highly skilled knowledge workers, and manufacturing facilities, which tend to employ lower skilled workers, is highly relevant to business location decision-making. Ideally, one would have defined industry sector, as well as functional, classifications to capture such intricate patterns of activities. Unfortunately, the Annual Business Inquiry dataset used in the context of this thesis records according to the SIC classification, which only accounts for the industrial sectors in which companies operate. The SIC classification does not encode any functional division of labour. On its own, the ABI data thus makes it impossible to classify businesses along both sector and function, to distinguish, for example, areas of London containing a drugs research and development centre or a drugs production facility. Using an exclusively industry sector view of economic patterns, these two activities are deemed equal, even though it is obvious that the drug research facility would require a different set of workforce skills, as compared to a production facility. Although this information would be very useful for a better understanding of the economic landscape of London, such data is not available in any current London-wide dataset.

Alternative datasets used to quantify and qualify economic activities do exist, for example commercial company databases such as OneSource, which holds detailed information on individual companies and individual business sites. Unfortunately, a review of such datasets showed that there were significant quality problems with some of the extended records, as well as the fact that such commercial databases relied again on SIC classifications to segmentise business activities, limiting the distinction along functional boundaries. In addition, the commercial nature and thus cost of procuring these datasets meant that they were not included in the final spatial database.

6.3.1.2 Accessibility as a concept

An important facet of the location characteristics that were deemed relevant to FDI location decision-making is accessibility. In general, the concept of accessibility can encompass both accessibility using different transport modes at different spatial scales (access to local shops by foot, public transport travel times to other areas of the city, international flight times) and the concept of co-location with other activities. Given the lack of publicly available, good quality bulk data on accessibility for different areas of London, two exemplar measures were selected to represent generalised public transport accessibility for a characterisation of London's geo-business neighbourhoods on a nonspecific basis: (1) public transport accessibility to Central London (defined as the centroid for the Central London town centre boundary) as the main hub of business, social, and cultural activities; and (2) accessibility to important transport facilities, (e.g., being within easy reach of airports offering international flights connecting firms to their global headquarters in other world cities such as New-York, Tokyo, or Paris), in this case ,accessibility to Heathrow (centroid of the Heathrow town centre boundary). Accessibility in this instance was measured as public transport travel time to these two destinations, as gathered from TFL's "Journey Planner" website.

Clearly, there is a need for companies to gain information on accessibility to areas other than Heathrow and Central London. Other transport infrastructures (e.g. airports, mainline international and domestic train stations, freight terminals) as well as other modes of transport (by car, on foot, for lorries, boats, etc.) are clearly relevant measures, and present a clear scope for future inclusion in the development of a geo-business classification.

More generally, the concept of accessibility encompasses different understandings of what investors understand it to be. Apart from multifaceted accessibility measures using different modes of transport and at multiple spatial levels, accessibility can also encompass spatial co-location with clients, partners, suppliers, or even competitors, as evidenced by the benefits of clustering detailed in the literature review. However, the measurement of these diverse location variables was outside the scope of this thesis and presents significant data collection, analysis, and presentation difficulties, including the development of convenient and user-friendly methods to capture these complex requirements from the investors using the proposed system. As a result, there is a clear scope for future work in qualifying accessibility measures relevant to business decision-making, going beyond generically applicable accessibility measures for a given location.

6.3.1.3 Issues with the use of town centres boundaries

The town centre boundary definition methodology limitations and errors, introduced through source data issues and methodological issues, were explored in detail by Lloyd (2004). Lloyd specifically classified errors in the raw input datasets, geo-referencing problems, and statistical issues encountered in the pilot study. Although some measures were developed to address these issues, most of these issues remain in the final town centre boundaries. These boundaries then represent only an estimation of "town-centredness", based on three components: economy, diversity, and property. The economy component looked at the concentration in employment in specific sectors: retail, food and drink, accommodation, leisure and culture-related activities, as well as office-based employment in public and private sectors. Significantly, the economy component negatively weighted against employment concentration in the primary industry-related sectors of warehousing, manufacturing, and utilities (ODPM 2004).

The exclusion of industrial production areas from the town centre boundaries definitions is significant in the context of this research, as although London's present economy is primarily driven by post-industrial knowledge economy sectors such as financial and business services, the creative sector and other sectors such as ICT, London's manufacturing, distribution, and logistics-related economic activities are still present and dominant in certain areas of London.

Given that the geo-business classification also takes account of these industrial activities, there is a mismatch between the modelling aims of this research and the lack of town centre boundaries representing areas such as industrial parks, manufacturing centres, and light industrial and logistics parks.

One example of the lack of representation of such areas is the business park of Park Royal, situated in West London (see Figure 43). The largest business park in London, Park Royal hosts 2,000 businesses and 40,000 employees, mostly small- to medium-sized companies. Looking at the footprint of Park Royal business park (as defined by the GLA's London Plan Opportunity Areas), the closest town centre boundaries of Harlesden, Ealing, and Acton fail to capture the activity of the business park. Although, as previously discussed, the geo-business classification encompasses data from spatial statistical units surrounding a given town centre, in the case of Park Royal, the LSOA selected for each town centre fail to include significant parts of Park Royal.

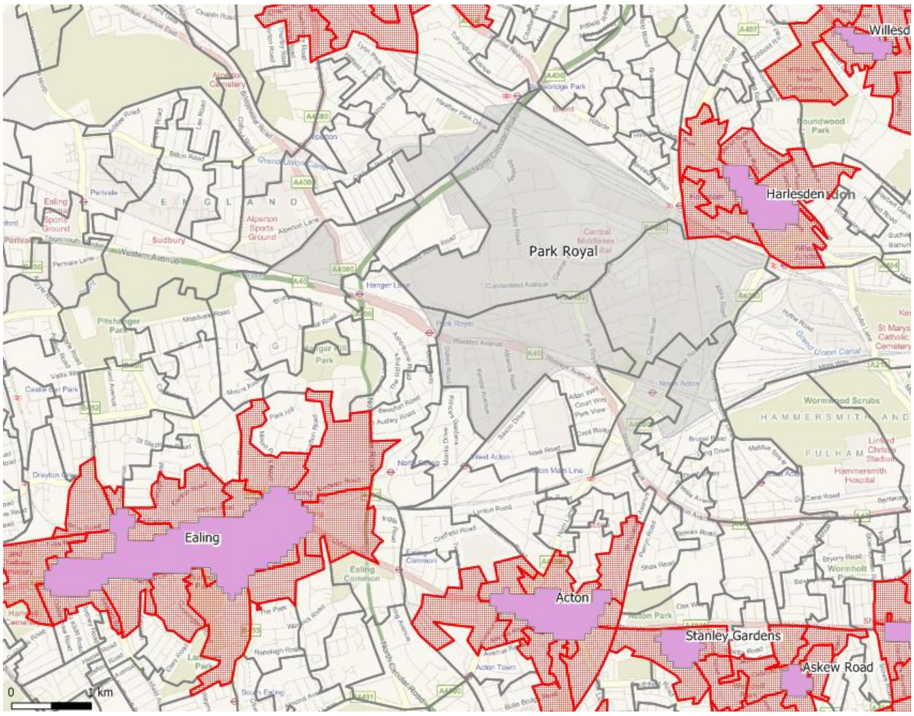


Figure 43: Park Royal Business Park and neighbouring town centres[47].

Given the methodology by which the town centre boundaries were developed, which weighs against the presence of retail parks and light-industrial areas, it is clear why business parks such as Park Royal are not represented in the town centre boundaries. However, the overestimation of the data collection area through the aggregation of different geographies (LSOA, MSOA, and wards) allows the qualification of London neighbourhoods on a wider scale than the narrow view set by the town centre boundaries, resulting in the coincidental inclusion of industrial areas in proximity to town centres. One example of this can be seen in the Wembley Area (see Figure 44), where the actual Wembley and Wembley Park town centres encompass most of the Wembley Regeneration Area.

[47] The town centre boundary is marked in pink; the individual LSOA attached to each town centre are highlighted in red; and the business parks are marked in light grey.

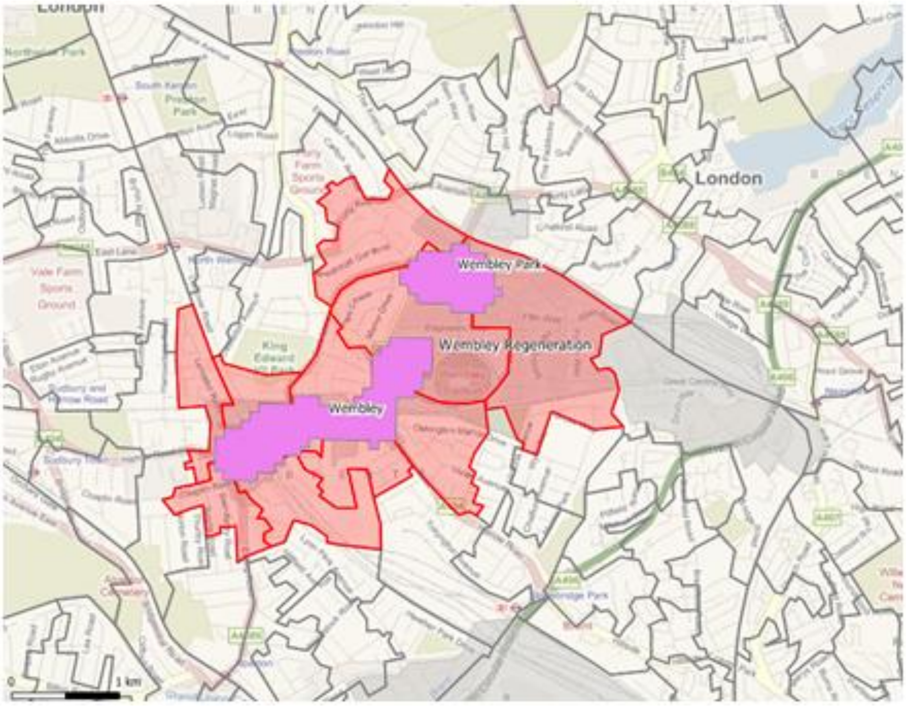


Figure 44: Wembley area town centres[48].

Ultimately, town centre boundaries in the context of the prototype development of a geo-business classification were selected as a current and relevant geography depicting existing London neighbourhoods and matching existing perceptions by FDI promotion experts. The development of alternative or supplemental boundaries representing more areas that can be characterised as geo-business neighbourhoods would certainly be relevant, but was ultimately deemed out of scope of the present work.

A future improvement of the geography selected for the geo-business classification would need to include such business parks in the geography. A pragmatic approach would be to define and add to the existing boundaries new areas representing industrial and logistics centres of activities, which can be considered another set of business “neighbourhoods”. A more involved methodological approach would be to adapt the town centre boundaries definition methodology to specifically detect and include such areas of industrial, manufacturing, or logistics, previously actively excluded from the original town centres boundaries. Such an adaptation of the original town centre boundaries work though would

[48] The town centre boundary is marked in pink; the individual LSOA attached to each town centre are highlighted in red; and the business parks are marked in light grey.

encompass all the data access quality and confidentiality issues which originally plagued the Town Centres Boundaries project, as detailed by Lloyd (2004).

6.3.2 Comparison of geo-business framework with geodemographic classifications

Comparing the creation process of the geo-business classification presented previously to a geodemographic classification methodology detailed by Webber (Harris et al. 2005, chap.6), there are many commonalities and historic linkages between the two methodologies. PCA as a tool for social area analysis evolved in the 1960s and 1970s (Moser & W. Scott 1961; Herbert 1968; Norman 1969; M. Flynn et al. 1972), and can be seen as a methodological precursor to the development of modern geodemographic classifications. The development of a spatial database reflects the first step of the methodological process, assembling a relevant, complete, and robust database of local indicators selected according to the relevance to the end user, which in turn are standardised and aggregated to a common geography.

However, apart from these methodological commonalities, differences exist between the geo-business method developed in this thesis and geodemographics. Geodemographics makes use of PCA as a variable selection tool to identify the main differentiating variables. In this context, PCA is used to identify variables with more explanatory power, i.e. variance they account for. Variables identified as possessing less explanatory power, typically associated with multicollinearity, are removed from the model. PCA also informs the weighting of the remaining variables to be included in the clustering algorithm, which groups spatial entities, i.e. zones, according to their similitude, based on the variables considered. Descriptive profiles are developed for each cluster, representing the different geodemographic profiles, which are then the outcome of a clustering algorithm; they do not represent PCA components!

For the development of the geo-business classification, PCA informs the variable selection process in an iterative process, with the resulting components serving as the basis on which town centre profiles are formed. A town centre is then qualified and measured not according to the original variables, but through the nine component scores, expanded into component profiles providing a descriptive narrative of their meaning. It follows that component profiles do not represent a geodemographic group in the classical sense, as they do not represent a clustering of similar areas, but rather, each town centre will have various degrees of similitude with a number of component profiles. The clustering and definition of a set of unique labels, one label attached to one area, which unambiguously characterises the population through the group profile, is actually one of the main benefits of geodemographics.

However, in the context of this research, the primary aim is to simplify and aggregate the spatial database of location variables deemed relevant to FDI promotion. The components presented here are such a simplification, while retaining the majority of the original dataset's variance. As such, the grouping of town centres into a set of exclusive groups and the characterisation of these groups has not been completed. This clustering of town centres into "true geodemographic groups" would use the component scores as input variables and produce a set of geodemographic classes based on these input variables.

There certainly is value in the definition of such a classification for a better understanding of the attractiveness of London's town centres to FDI. However, in the context of this research, one of the aims is to produce a Spatial Decision Support System enabling investors to compare and contrast potential investment locations according to their own requirements. Individual investors' requirements, preferences, and trade-offs will be captured in the SDSS through a Multi Criteria Decision Making methodology, enabling the deduction of absolute weights for each component profile. The result of this process then is the computation of a suitability index, used to rank town centres according to the investor's individual needs, providing the decision maker with a set of location recommendations to explore and compare.

The weights attached to component profiles will certainly differ between individual classes of investors, thus influencing the ranking of town centres. A geodemographic a priori clustering of town centres into a set of groups would not lend itself to the bespoke classification and ranking of town centres as proposed here, a too stringent all-or-nothing exclusive classification, which does not allow for the characterisation of multiple coincident and coexisting business environments.

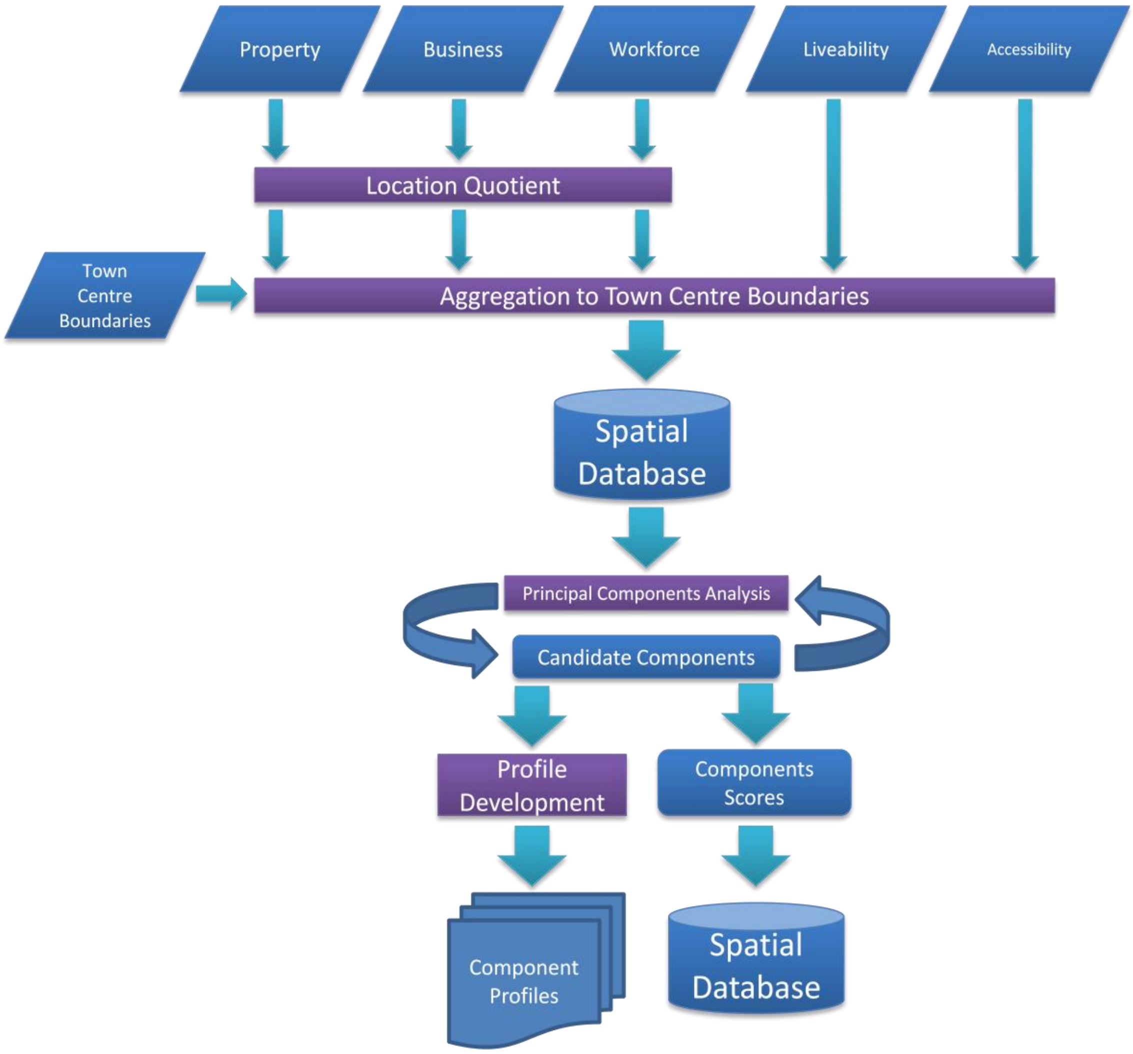


Figure 45: Development process schema of the geo-business classification

6.4 Conclusion

Using methods commonly associated with geodemographic classifications, this chapter explored the development of a parsimonious geo-business classification capable of characterising and differentiating business environments from the original spatial database (see Figure 45 for the schematic data processing method). Principal Components Analysis revealed nine components describing the salient characteristics of the original database, highlighting different aspects of neighbourhood activities and characteristics relevant to business site location decision-making. For each component, a rich profile describes, quantifies, and qualifies the most significant variables attached to each component, creating a comprehensive and understandable account of the distinctive features, as well as linking back each profile to its most or least representative town centres. The final geo-business classification enables the exploration of areas of London exhibiting similar behaviours and characteristics, and characterises and distinguishes these areas to enhance the comparison and in effect, the marketing of these areas for business site location decision-making.

In conclusion, the work presented in the last two chapters contributes to the overall research goal of this thesis, and specifically fulfils the thesis research aims of: (**1b**) the discovery of a coherent, consistent and relevant geographical framework for modelling London's business neighbourhoods, by which to integrate disparate spatial datasets representing identified business location variables; and (**1c**) implement a geo-business classification of London neighbourhoods for describing and distinguishing areas based on multifaceted business environment characterisations.

The development of the final geo-business classification forms the database component of the proposed SDSS for FDI location decision-making, allowing investors to explore, characterise, and compare different London locations according to their own needs and wants. The following chapter is concerned with the development of the model base component of the SDSS, formalising this decision-making process and generation of location recommendations.

7 Multi-Criteria Decision Making model base

The previous chapter presented the development of a geo-business classification enabling a rich and multidimensional description of different business environments in London. However, to enable investors to explore, compare, and rank candidate locations against this rich data source, a Multi-Criteria Decision Making (MCDM) methodology applied to location analysis needs to be developed, constituting the model base of the proposed SDSS.

This chapter reviews relevant MCDM methodologies that can be applied to the selection of potential business site locations resulting from investors' location preferences. For three potential MCDM methodologies, this chapter will evaluate benefits and drawbacks of each method in the context of the case study. This review arrives at the conclusion that the Analytical Hierarchy Process (AHP) is the most suitable methodology given the requirements of the business location decision-making process.

The potential of AHP for supporting business location decision-making is further explored through the implementation of a functional mock-up. This mock-up enables a detailed exploration of some key aspects of the AHP methodology, as implemented for the case study prototype, representing the model base component of the proposed business location decision-making SDSS.

7.1 Multi-Criteria Decision Making

SDSS rely heavily on Multi-Criteria Analysis methodologies as their model base, i.e. the analysis of complex decision problems involving no commensurable, potentially conflicting criteria against which alternatives need to be evaluated. Indeed, the assumptions behind MCDM analysis match closely the aims of Decision Support Systems (Malczewski 1999). Multi-Criteria Analysis assists stakeholders and decision makers in analysing the decision problem at hand, specifically for decisions which present trade-offs between different objectives, with no obvious optimal solution. (Reyck et al. 2005)

Given this definition, Multi -Criteria Decision Making is concerned with the evaluation of alternatives based on potentially conflicting objectives. Such conflicts might arise between the "quality" of office space, in terms of accessibility or fit out standard, and the site accessibility to a qualified workforce, for example. The value of MCDM then lies in the analysis of preference trade-offs, such as an investors' choice to compromise on the quality requirements for office space in order to gain access to a larger talent pool of potential employees.

MCDM methodologies are subdivided into two approaches, according to the characteristics of the decision problem: Multi-Objective Decision Making (MODM), where a decision maker needs to design the best alternative, given a set of potentially conflicting objectives; or Multi-Attribute Decision Making (MADM), where a preference decision has to be taken over a finite set of alternatives, with a multitude of potentially conflicting attributes (criteria) to be considered. In the context of this case study, given the finite, relatively small number of decision alternatives (208 town centres), Multi-Attribute Decision Making (MADM) methodologies are deemed appropriate, and this review will focus on such methodologies.

For MADM, the decision-making process is subdivided into a number of stages (Fülöp 2004; Reyck et al. 2005):

1. **Decision framework (define the problem):** Establish the decision context, objectives, and stakeholders. Identify the alternatives to be appraised.
2. **Define the decision criteria:** Decision criteria need to be defined as objective measures of the overall decision-making goal(s).
3. **Evaluate alternatives against criteria:** As input data to the decision-making process, alternatives are evaluated against criteria. This assessment can be objective, against some common scale of measurement, or subjective according to the subjective assessment of an evaluator. The result is a set of criteria scores for each alternative.
4. **Generate weighted outcome:** Decide on and apply weights to each criterion to reflect its relative importance. Combine these weights and apply to the criterion scores of each alternative to derive an overall value for each alternative by which to rank all considered alternatives.
5. **Inspect results:** Evaluate the resulting alternatives, ranking from most suitable to least suitable, against original preferences and goals.

7.1.1 MADM in the context of spatial business location decision-making

The first three stages of the MADM process have already been defined in this thesis through the review of business location decision-making processes, as well as the development of the spatial database component. This chapter is concerned with the development of a suitable methodology for the generation of an overall weighted outcome from a set of geographically defined alternatives, i.e. the London town centres geographical framework. The two criteria considered are the geo-business classification and accessibility measures. The aim is the integration of a suitable MADM methodology with a spatial database component, or in other words, the model base with the database, to achieve the "*aggregation and analysis of spatial data and the decision makers' preferences into a discrete decision alternative*" (Ghosh 2008, p.366).

Three MADM methodologies suitable to support business location decision-making in the context of this thesis were evaluated:

1. Simple Multi-Attribute Rating Technique (SMART),
2. Conjoint Analysis (CA),
3. Analytical Hierarchy Process (AHP).

For a detailed introduction to each methodology and review of benefits and drawbacks, please refer to Appendix 11.5 – "Introduction to MADM methodologies".

7.1.2 Discussion of choice of MCDM methodology

This section is concerned with the evaluation of the three chosen MADM methodologies, to determine which is most relevant to the decision-making process of business site selection. Specifically, the MADM methodology implemented for business location decision-making in London needs to:

1. Model the complex process of business location decision-making, involving multiple decision variables and the characterisation of different London business environments;
2. Allow non-expert users to compare, contrast, and prioritise decision variables, including the different geo-business environments, according to their specific needs; and
3. Capture rational preferences, as well as emotions and feelings, of location variables that users have and express these ambiguous conditions in absolute weights attached to the location variables.

The following sections evaluate each of these statements against the three candidate methodologies:

7.1.2.1 Question 1: Ability to model a complex decision-making process:

In Conjoint Analysis, the decision maker expresses his location preferences not directly, through judgments of the importance of location variables as in SMART or AHP, but by comparing sets of constructed alternatives, stating his preference for a given alternative. In CA, these constructed alternatives are either hypothetical business site examples or real town centres and their characteristics. The challenges then lie in the design of credible and realistically constructed example locations to use in the questionnaire, complicated by the complexity and diversity of the town centre makeup. Depending on the methodology, a varying number of comparisons need to be made between alternatives for CA to generate reliable absolute weights for the constituting variables. In the case study, there is a need to evaluate 11 variables[49], resulting in a full factorial design of over 2,000 alternatives to evaluate. The overwhelming number of alternatives to evaluate makes the design of an efficient and user-friendly survey impossible.

By contrast, AHP breaks down the decision-making problem, grouping similar decision variables at several levels, enabling the expression of a multi-level hierarchy of decision variables. This model breaks down problems into sub-problems, going from the general and less controllable issues to specific and quantifiable problems. In the case of the established spatial database component, AHP allows the decision maker to first decide on the importance of accessibility overall, versus the location business characteristics. On a second level then, the user can assign importance to different geo-business classes, and separately express the importance of accessibility to certain locations, resulting in 37 pair-wise comparisons overall.

MADM methodologies, including SMART, have started to use AHP-type decision trees to subdivide the decision criteria and structure the decision-making process (Forman 1993, p.24). Both AHP and SMART are then able to use a hierarchical decision tree to express and retain a segmented approach in the decision model. This enables both approaches to guide the decision maker through a simple structured questionnaire evaluating groups of variables, taking advantage of the innate human capability to make sound judgments about small problems, as opposed to the evaluation of complete and complex sets of alternatives in CA.

[49] With a large number of variables and measurement levels, a fractional factorial design of the questionnaire is needed to reduce the number of comparisons to be made. In the case of 11 variables at two levels, a full factorial design would result in 2,048 (2^{11}) comparisons!

7.1.2.2 Question 2: Prioritise location decision variables according to user preferences

As detailed previously, both AHP and SMART are able to structure the complex multi-criteria decision-making process to generate a decision model relevant to business site selection although there are differences in the methodologies that influence questionnaire design and the ease of the task for the user. AHP and SMART differ in how the value function for individual criteria is constructed. SMART relies on the assignment of numerical values to individual criteria levels, including a best and worst case scenario, and then asks the user to choose trade-offs from these best and worst case scenarios. In the case study example, the two scenarios would be: Location A has the shortest travel time to Heathrow and the longest travel time to Central London, while location B has the shortest travel time to Central London and the longest travel time to Heathrow. From these two alternatives, the user would have to make his preferred choice.

Forman & Gass (2001, p.483) contend that AHP presents a more flexible environment for the capture of preferences than SMART. Whereas MAUT approaches require the decision maker to construct a (sometimes artificial) scale against which to consider the swings in alternative values between worst and best case scenarios for each objective, such considerations are not required in AHP. AHP generates pair-wise comparisons of two criteria, answered by the user not through a numerical evaluation, but by a stated preference such as "moderately" or "strongly" preferred. In the case study example, the user would compare accessibility to Heathrow versus accessibility to Central London and make a judgment on which factor is more important to him. It is generally accepted (Forman 1993, p.24) that such approximate judgments are easier to make for decision makers than numerical comparisons in SMART, and the accuracy of such verbal pair-wise comparisons has been demonstrated repeatedly (Saaty 2008).

7.1.2.3 Question 3: Capture rational preferences and users emotions and feelings:

MADM methodologies capture and formalise the tacit preconceptions, preferences, and trade-offs that users have when making decisions. CA relies on users picking alternatives that are deemed most suited to their needs, and the weights of variables are derived from these decisions. SMART evaluates trade-offs between different location characteristics, quantifying the weights attached to individual variables from these trade-offs.

AHP on the other hand derives the weights from the pair-wise comparison of decision variables. AHP forces the user to consciously think about and make a decision on the relative importance of each variable when compared with the rest of variables, engaging and capturing tacit preferences to arrive at both a set of final location variable weights and location recommendations. AHP replicates how an individual naturally resolves a multi-criteria decision problem, and as such is both a descriptive and prescriptive model of decision-making (Forman & Gass, 2001).

7.1.3 Conclusion

The Analytical Hierarchy Process methodology satisfies the conditions set out in the previous section, while at the same time structuring and effectively managing the complexity of the decision-making process. Conjoint Analysis was deemed too complex to implement given the need for the construction of relevant, realistic example alternative business sites, and the resulting number of comparisons needed without any structuring of the process. SMART presented no relevant benefits over AHP, and Forman and Gass (2001, p.483) argue that AHP presents benefits over SMART in terms of simplicity, ease of understanding, and accuracy.

AHP offers the best methodology to construct a relevant decision tree incorporating the spatial database variables developed in the context of this thesis. AHP relies on pair-wise comparisons of decision variables, allowing the generation of complex decision-making models, while at the same time managing and limiting the complexity of the questionnaire presented to users. AHP was designed to capture and formalise perceptions and judgments, based on rational reasoning, as well as feelings and emotions, on the relative importance of variables, breaking up the decision-making process into smaller sub-problems enabling users to make rational decisions.

In the context of this thesis, the properties of AHP methodology will allow the construction of a structured questionnaire of pair-wise comparisons of variables taken from the geo-business classification spatial database, capturing users' preferences and feelings concerning the geo-business environments qualified in the nine components. From these relative judgments, AHP will generate absolute weights to generate candidate locations suitable according to users' needs and wants.

7.2 Evaluation of AHP methodology

To evaluate the suitability of AHP as a MADM methodology for the case study, a Microsoft Excel spreadsheet-based functional mock-up was developed. This mock-up builds on the work done in the development of the relevant geo-business classification spatial database component, incorporating both the neighbourhood environment characterised through the nine geo-business classification components and accessibility to some example transport hubs (Heathrow and Central London).

The spreadsheet (see Figure 46) not only models the pair-wise comparisons and generation of weights of the individual variables according to the AHP methodology, but also incorporates the spatial database of geo-business classes and accessibility measures, allowing the computation of the ranked list of London neighbourhoods according to individual requirements.

This rapid but functional Excel implementation of the business location decision-making process allowed the evaluation of the AHP methodology, in terms of its relevance to the case study database and decision process, as well as the exploration of specific implementation and computation issues connected to the methodology. The experience gained from the implementation and evaluation allowed the refinement of both functional requirements and exploration of issues at an earlier stage of the process before the prototype implementation stage of the final SDSS.

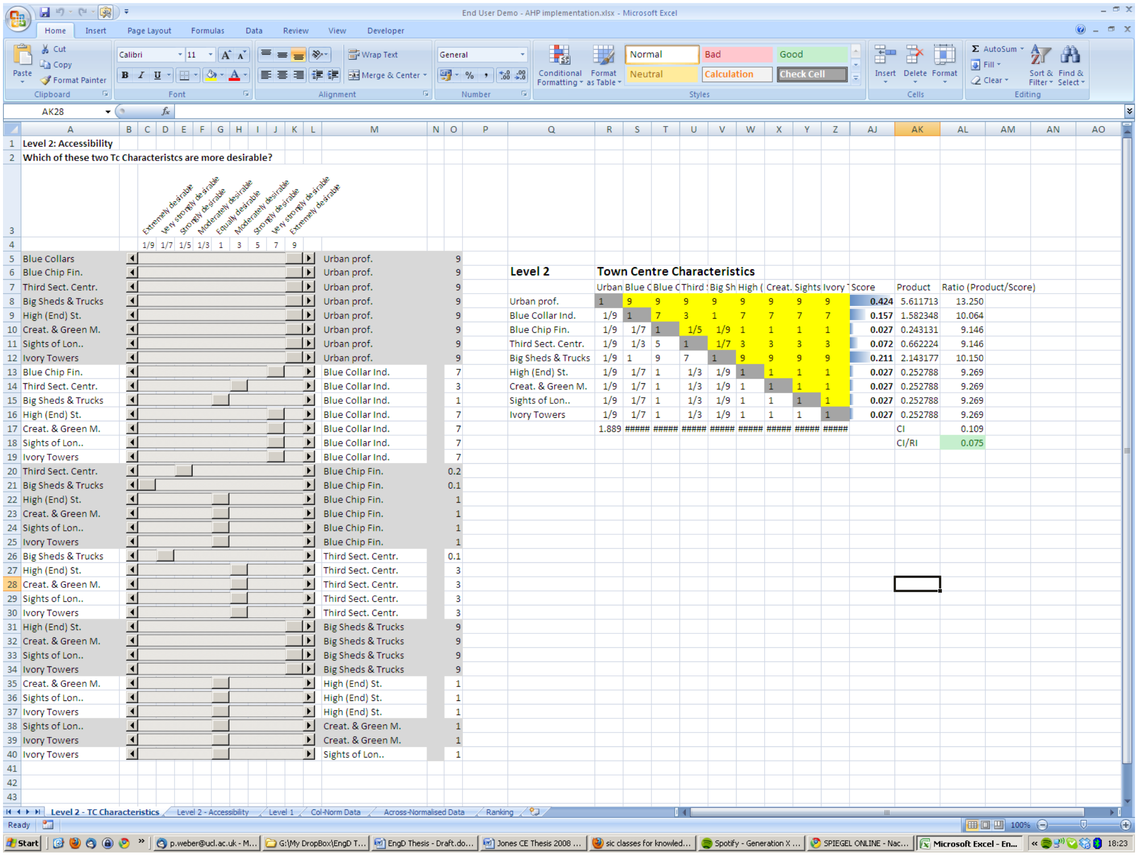


Figure 46: Functional mockup screenshot of AHP for business location decision-making, showing the pair-wise comparisons interface

7.2.1 Discussion of Excel prototype implementation

The spreadsheet-based rapid testing of the implementation of the main functionality of the proposed decision support methodology and data, minus the geo-visualisation of the results, allowed a better understanding of a number of methodological and data issues connected with the implementation of the AHP process. These issues are discussed in more detail in the following section and include the presentation and order of the pair-wise comparisons required from the user, different standardisation methodologies and their impacts on weighting and results, and the validity and comparability of the final weights and resulting location recommendations.

To explore these issues in more depth, preliminary, informal user tests and discussions of the system were carried out with academic subjects, pointing out basic methodological and presentation issues. These tests helped elicit feedback on how users perceive or understand the AHP process and business location decision-making. At a later stage, test results are incorporated into the design of the detailed user testing campaign with the prototype system, detailed in Chapter 8 – "Prototype SDSS".

7.2.1.1 Decision hierarchy

AHP relies first on the identification of the relevant criteria or variables that will influence the decision-making process, in this case the location variables that define the spatial data framework relevant to FDI location decision-making. AHP relies on the categorisation of these relevant criteria into a tree-like hierarchical structure, going from broad to specific criteria. In the context of this thesis, the spatial database contains the geo-business environment profiles, as well as accessibility measures, which were modelled as two separate sets of variables or branches. For each of these two criteria, their constituent sub-criteria can be modelled as sub-branches of the decision tree. The case studies' two-level hierarchy is presented in Figure 47.

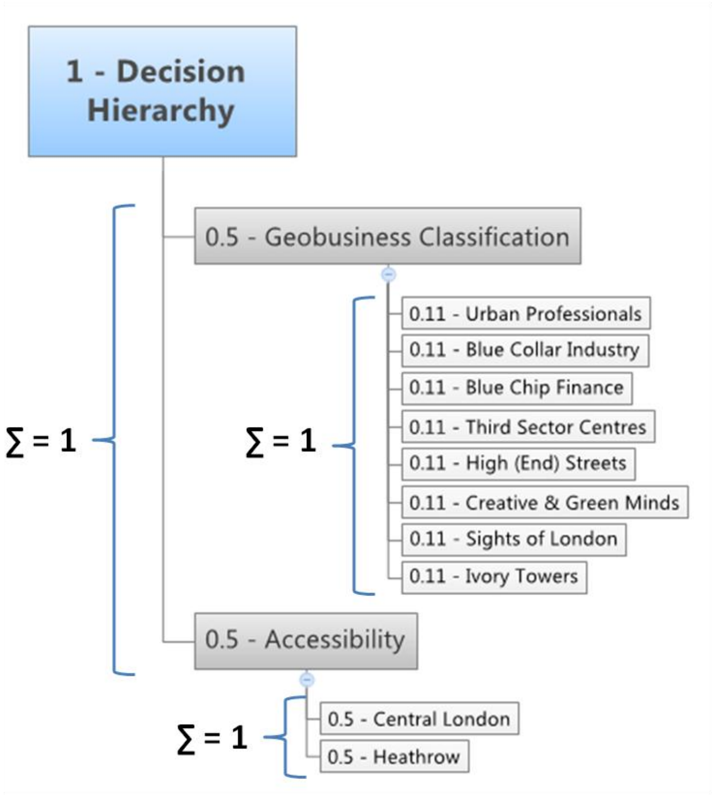


Figure 47: Implemented AHP Hierarchy with default weights

For each hierarchical level of the decision tree, AHP assigns pair-wise comparisons for all constituent variables to generate normalised weights at each level (summing to 1) for each branch and sub-branch. One issue that arises is the number of comparisons that are generated for each branch. The number of comparisons is defined by the number of variables at a given hierarchical branch and grows almost exponentially as more variables are compared against one another, leading to very long questionnaires. The subdivision of decision variables into the hierarchy thus serves as a way to *"divide and conquer"* the problem and limit the number of pair-wise comparisons.

In the case of the geo-business classification, nine variables generate 35 pair-wise comparisons. Although this is deemed acceptable in the context of the prototype system, ways to further reduce or subdivide the location variables are clearly needed if one wants to include more variables at a later stage or allow users to construct their own decision hierarchies.

7.2.1.2 Pair-wise comparisons questionnaire design

The design of the decision hierarchy and the resulting pair-wise comparisons structure is a subjective decision made by the questionnaire designer. There are two choices: a top down approach, with the user asked the more general pair-wise comparisons first, such as geo-business environments versus accessibility, followed by the detailed geo-business environment preferences and accessibility measures; or a bottom-up approach with the detailed levels first, followed by the generic comparison of geo-business versus accessibility. Following suggestions from several early users of the Excel mock-up, it was determined that the user would have a better understanding of the AHP process if he started with the detailed levels first.

The design of the pair-wise comparisons, and the attached fundamental scale levels, can theoretically be adapted to include different values and descriptions to suit specific implementations. This would include, for example, leaving out the extreme importance level, or assigning different numbers to the individual preference levels. For this study, the existing intensity levels and textual descriptions were found to be relevant when designing and reviewing the decision-making process, and were therefore retained.

7.2.1.3 Normalisation of alternative scores

The principal outcome from the AHP process is a set of weights attached to all levels of the hierarchical decision tree. These weights always sum to 1 (100%). See Figure 47 for a given decision level or group. From these two levels of weights, a composite absolute weight needs to be generated, encompassing the relative importance of all variables. For example, the absolute weight of "Accessibility to Heathrow" would be:

$$a^{abs} = A * a^{rel}$$

with a^{abs} *the absolute weight of Heathrow accessibility;* A *the weight of overall accessibility; and* a^{rel} *the relative weight of accessibility to Heathrow.*

The end goal, of course, is to combine these weights with the individual scores recorded for each variable in each location (alternative) recorded in the spatial database, to generate an absolute weighted score for each town centre. The generation of this weighted score for each town centre is only possible through a suitable normalisation methodology to enable the calculation of a consistent suitability index taking into account both geo-business class scores and the accessibility measures.

The nine component scores generated from the PCA analysis are normally distributed index values centred on 0. The PCA factor loadings represent the "likeness" of individual town centre characteristics to a given component and can be considered inherently comparable[50]. In order to enable the direct comparison between them and the accessibility measure though, they were rescaled[51] to values between 0 and 1 using the following formula:

$$y = \frac{x - x^{min}}{x^{max} - x^{min}}$$

The original PCA component scores for each town centre are generated by multiplying the standardised (z-scores) original variable values by the component loading value for each town centre. The rescaled values then signify how representative a component is for a given variable (scores), with the maximum score (= 1) representing most representative and the minimum score (= 0) representing the least representative town centre for the given variable.

On the other hand, the public transport travel times to Heathrow and Central London were initially represented as public transport travel times ranging from 0-120 min. This meant that low values were considered more accessible (i.e. "good") and high values were considered less accessible (i.e. "bad"). A modified rescaling algorithm was used:

[50] PCA factor loadings are comparable, as they are normally distributed and centered on 0 indexes, with negative values possible.

[51] Rescaling introduces no distortion to the variable distribution, retaining a one-to-one relationship between the original and normalized values, which was deemed appropriate in the circumstances.

$$1 - y = \frac{x - x^{min}}{x^{max} - x^{min}}$$

The values for each variable can be rescaled separately, or rescaled across variables to take into account the absolute highest and lowest component scores. Both methods and their impact on the resulting outcomes were implemented in the Excel mock-up. Although the ranking of individual town centres did differ for the same weights between the two standardisation schemes, the differences were deemed to be small enough to be negligible and the original rescaling algorithm was retained.

7.2.1.4 Consistency Ratio

Within the AHP methodology, a specific measure is developed to check for the quality of the decisions. The Consistency Index gives a measure of the quality of the decision maker's preferences, in other words, whether the decision maker was consistent when evaluating and expressing his preferences using the pair-wise comparisons. Appendix 11.5.3.2 contains a detailed explanation for the generation of the Confidence Ratio (CR).

If the CR is above a certain value (10%), then decisions are deemed inconsistent, and the decision maker would need to revisit the questionnaire and reconsider the pair-wise comparisons. No explicit system to make the user aware of the Consistency Ratio and the implications for the decision-making process was developed for the Excel mock-up, but the values were recorded in order to analyse the consistency of decisions made by different users. A more detailed discussion of the consistency of users decisions is presented in Section 8.3.2.3, where the consistency of decisions and the resulting weights are analysed in the context of the prototype SDSS.

7.3 Conclusion

This chapter presented relevant frameworks for MCDM and discussed their applicability to the specific context of the case study. The suitability of Simple Multi-Attribute Rating Technique, Conjoint Analysis, and the Analytical Hierarchy Process were evaluated in terms of the relevance to the problem, as well as the practicalities of a complex and hierarchical set of location variables to be evaluated. The ability of AHP to support non -expert users in exploring, expressing, and prioritising rational arguments and location preferences, as well as ambiguous emotions and feelings about location characteristics, was investigated through a functional mock-up, integrating the geo-business classification spatial database in a rudimentary but functional spreadsheet interface.

Testing of the AHP process in the context of the proposed SDSS, minus the geo-visualisation of the results, provided a better understanding of a number of methodological and data issues. The implementation of the AHP methodology allowed the discussion and development of a decision hierarchy and generation of weights from pair-wise comparisons, the presentation of the pair-wise comparisons questionnaire, and the generation and standardisation of weights and final recommendations.

The experience and knowledge gained in the review, selection, and implementation of the chosen MCDM methodology in the specific context of the case study enables the integration of the previously developed SDSS components, through the development of a user interface detailed in the following chapter.

8 Prototype SDSS implementation

This chapter details the implementation of a prototype spatial decision support tool used to validate and gather feedback on the data framework for business location decision-making. This implementation focuses on the functionality required for inward investment promotion decision-making.

The prototype integrates AHP decision-making within a site-selection tool designed to support inward investors seeking to set up new operations within London, UK. The web-based prototype implementation guides potential investors step-by-step through the location decision-making process, eliciting the factors influencing their location decisions. From these location preferences, the system computes individual location recommendations. Investors are then able to compare and contrast different London neighbourhoods and gain a better understanding of the attractiveness of different London locations.

The software development uses rapid application development methodologies, supported by the extensive use of existing software libraries and external tools to enable the rapid implementation of a working prototype. Through a scenario-based user evaluation of the system, the potential of AHP for this form of spatial decision-making is reviewed. The analysis of the results focuses on the consistency of outcomes for both expert and non-expert users; general comments from users on the usability of the system; and the potential adaptability of AHP to include further decision variables.

8.1.1 Context of prototype development

Previous work with Think London resulted in the development of a Geographical Information System capability at the company (Weber & Chapman 2009), composed of a spatial database relevant to FDI investment decisions, along with desktop and web based mapping tools to enable the production of bespoke maps. These maps provided investors with high-quality information about London strengthening engagement with investors by adding a tangible product to the service offer and differentiating Think London from other FDI investment promotion agencies. Whilst the GIS benefits to investors are undeniable (see Weber (2008)), the GIS proved to be primarily a reactive product, used to confirm and support a location choice already under investigation. Think London still lacked a formalised process by which they could capture and understand the detailed decision-making process an investor goes through when deciding on a setup location in London. As a result, Think London also lacked the tools to systematically guide investors to the best business location in London.

This insight was the seed from which this Engineering Doctorate project was developed, with the aim of contributing towards a better understanding of business location decision-making processes, and hence, the development and evaluation of a Spatial Decision Support System, specifically in the context of Greater London.

SDSS are composed of four principal components: (1) a database component, in this case the geo-business classification relevant to business location decision-making; (2) AHP as the implemented MCDM methodology representing the model base, and (3) the computation base to generate relevant location recommendations. The fourth component, still missing, is the user base, integrating the aforementioned components into a system interface facilitating user interaction and the effective exploration of the solution space under consideration. In the specific context of this case study, this entailed the development of a user interface guiding and advising investors through the business location decision-making process, making use of the constituent database and MCDM methodology to explore and choose a business location.

The interface captures users' location preferences and requirements through a questionnaire, in this case the AHP pair-wise comparisons. The system compares the outcome of the requirements questionnaire against a spatial database of location-dependant variables to compute a ranked list of London locations according to the investor's criteria. The result of this analysis is presented to the investor through a mapping interface, where he or she can explore, compare, and contrast a list of recommended London neighbourhoods. Because this can be an iterative process, the investor can return and refine his requirements and assess the impact on the system's location choices.

A fully functional prototype is needed to validate the relevance of this methodological approach to business location decision-making, and demonstrate the potential benefits of improved site selection. Specifically, this evaluation focuses on the relevance and consistency of location recommendations, proving the usefulness of the geo-business classification to business location decision-making, as well as confirms that AHP is an appropriate model of business location preference and trade off processes.

Given this focus on the validation of the methodology and database, the evaluation goals did not include the usability of the user interface. Although coincidental comments made by users regarding usability issues with the interface were recorded during user testing, these comments are only be summarized here, and are reserved for further refinement of the interface.

In the context of the knowledge transfer aspect of the Engineering Doctorate sponsored by Think London, the validation of the methodology demonstrated in the prototype presents a proof of concept. The sponsor can potentially make use of the work presented here to develop a refined iteration of the system, to be used productively with foreign investors.

8.2 Implementation strategy

Software development methodologies vary mostly according to the degree of structure and rigidity in the methods and rules to be followed. Examples of early formalised methodologies include linear waterfall processes such as Structured Systems Analysis and Design, which follows a sequential development process leading from requirements analysis, design, coding, evaluation, and documentation, with little room for the iteration of these stages to include user feedback. More flexible methodologies allowing for fast iterative prototyping and integration of user feedback include Rapid Application Development, Lean Software Development, Extreme Programming (XP), and AGILE. What is clear is that any software development project falls into a continuum between these extremes, and needs to follow some rules in order to be successful.

Regardless of development methodology, the general steps in software development encompass not only the development per se, but also steps before and after the development takes place. These include requirements gathering and analysis of the problem to be solved, developing an implementation plan, the actual development of the software code, testing of the software, and deployment and maintenance of the application.

Requirements gathering and problem analysis are addressed in this chapter through a review of the work done previously in the context of the development of the spatial database and geo-business classification, leading to a detailed knowledge of the main location variables relevant to business location decision-making. Previous work also informs the requirements regarding decision-making processes of inward investors, enabling the development of both a relevant geo-business classification database and the MCDM methodology. This detailed knowledge enables the development of both functional and data requirements for the prototype system.

The implementation plan then gives an overview of the fundamental structure of the prototype system, from database, user, and model base. The system implementation is based on a lightweight server-client architecture, including web-based client interface interacting minimally with a web-server acting as the computation base. Wherever possible, the proposed infrastructure leverages external software and libraries, as well external web services, to render key user interface elements, such as the background map and graphs.

Testing and user evaluation also forms an integral part of any software development effort. Both informal and more formal feedback from users and domain experts was gathered and integrated throughout the development process.

8.2.1 Development methodology

For the actual development process, given the limitations of a single person developing the system, and the need for rapid progress and validation of the implementation efforts, AGILE (Abrahamsson et al. 2002) was chosen as a suitable software development methodology. AGILE, a methodology originally developed as a response to deficiencies seen in most waterfall models, can be characterised by the following manifesto (Agile Alliance 2001) :

Individuals and interactions *over processes and tools*

Working software *over comprehensive documentation*

Customer collaboration *over contract negotiation*

Responding to change *over following a plan*

These new principles respond to some of the most persistent criticisms of waterfall models of the past, and enabled a software development methodology in this case that was characterised by a rapid evaluation of basic functionality by continuous feedback from test users, through informal demonstration of feature incomplete software parts. In addition, the process also involved frequent face-to-face communication and feedback from both academic supervisors and other research staff with expertise in software development, and meetings with industrial supervisors, which provided the opportunity to respond to user comments and integrate new and changing requirements feedback into the prototype system.

8.2.2 Requirements gathering

The context of the development of the case study of FDI location decision-making support was to demonstrate for research purposes, as well as to the industry sponsor Think London, the viability of a spatial decision support environment based on the geo-business classification developed previously, combined with AHP methodology.

Considerable work with investors and investigation of decision-making processes through both primary and secondary research informed the design of the research framework guiding the system infrastructure. AHP was determined to be the most suitable MCDM methodology to guide investors through the decision-making process. The system thus needs to include an interface allowing potential investors to explore and rank the different relevant location variables using AHP, with the output being a ranked list of London neighbourhoods, which users can explore graphically. The choice of AHP also informed the functional requirements of the interface, in this context the ability for the pair-wise comparison of the individual components of the decision model detailed by the tool, containing both the geo-business classes and the accessibility measures.

The proposed functionality requires the implementation of a decision hierarchy including both the geo-business classification and some example measures of public transport accessibility. The AHP process methodology works by asking the user to express their location characteristics preferences through pair-wise comparisons in this hierarchy. From these comparisons, the system then needs to generate absolute weights for all decision variables and compute the rank of each London neighbourhood. The results of the AHP decision-making process need to be presented to the user in a geo-visualisation interface. Such a mapping interface needs to allow for the exploration and comparison of recommended London neighbourhoods, as defined by the absolute weights generated through the AHP process. The interface needs to enable the user to visually compare, contrast, and rank potential business locations, supported by a visualisation of the relevant location variables for each neighbourhood.

8.2.3 Implementation design

Through the adaptation of the AGILE methodology for the development of the prototype system, changing requirements and adjustment to both the user interface and functionality were permitted.

Before the actual development effort started, non-functional graphical mock-ups of the main user interface elements were developed. These mock-ups (for example Figure 48) were designed to communicate with the client in the earliest stages of the design the process a user would go through with the tool, what the main functionalities would be, and how the end results would be visualised. These mock-ups allowed the client to gain a better understanding of the project, and enabled a discussion and gathering of feedback on design, functionality, and interfaces at the earliest stages. This process enabled a better understanding, through communication with the stakeholders, of both the usability and functionality of the system, providing useful guidance for the design and development process.

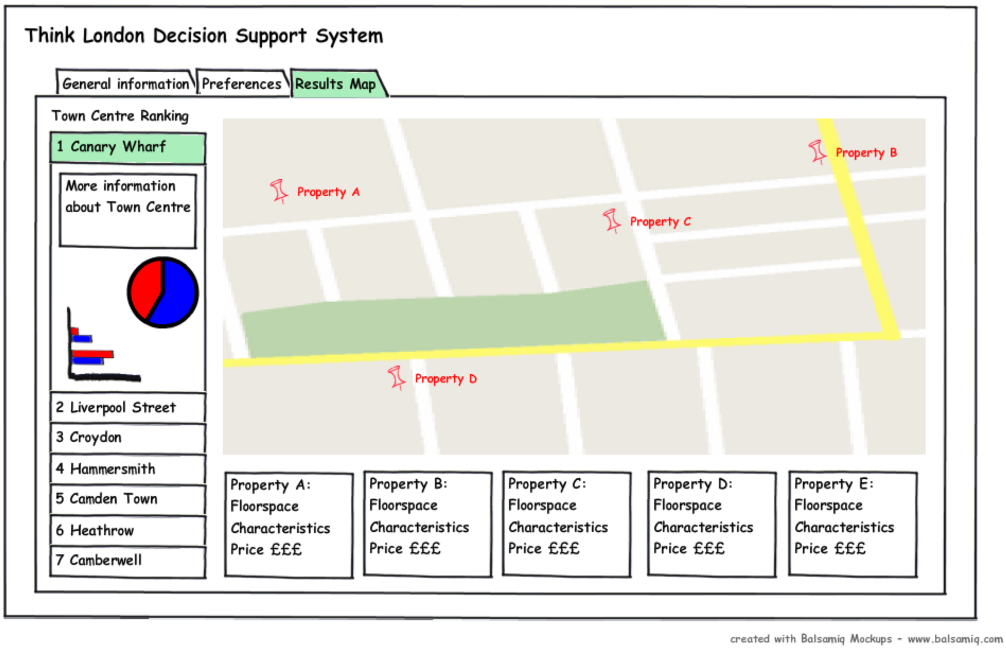


Figure 48: Example mock-up used in the development process

In the same spirit, before the development effort started in earnest, the MCDM methodology (AHP) was evaluated using a very basic Excel spreadsheet implementation (see Section 7.2.1 – “Discussion of Excel prototype implementation”). The spreadsheet not only modelled the pair-wise comparisons and generation of weights of the individual variables according to the AHP methodology, but also incorporated the spatial database of geo-business classes and accessibility measures, already allowing the computation of the ranked list of London neighbourhoods according to individual requirements.

This approach of rapid testing of the implementation of the main functionality of the proposed system, minus the geo-visualisation of the results, led to a better understanding of a number of methodological and data issues.

As a result, both the mock-ups and Excel implementation allowed the refinement of both requirements, as well as exploration of issues that would have arisen at the development stage, and thus saved time in the development process by exploring these issues before extensive development efforts began.

8.2.4 Technical infrastructure

The technical infrastructure of the actual prototype implementation was focused around the development of a client server based model, as commonly found in Rich Internet Applications (RIA). Rich Internet Applications are characterised as web applications, which function to the user like desktop applications in terms of richness of the interfaces, interactivity, and speed of response to user inputs. The architecture of the system is composed of two major components, detailed as well in Figure 49:

- The web server component delivers the needed data to the web client on initial load of the web site from the web server. The server then serves as the computation basis, processing the pair-wise comparisons to deliver the final weights for each location variable using R as the processing engine.
- The rich web client interface implements the user interface elements, presenting and managing the pair-wise choices, submitting to the server the pair-wise comparison judgments to receive back the final weights to update the decision tree. Using a local database of town centre values, the client also manages the geovisualisation and exploration of the location recommendations. This functionality is run on the client using JavaScript libraries such as ExtJS and OpenLayers.

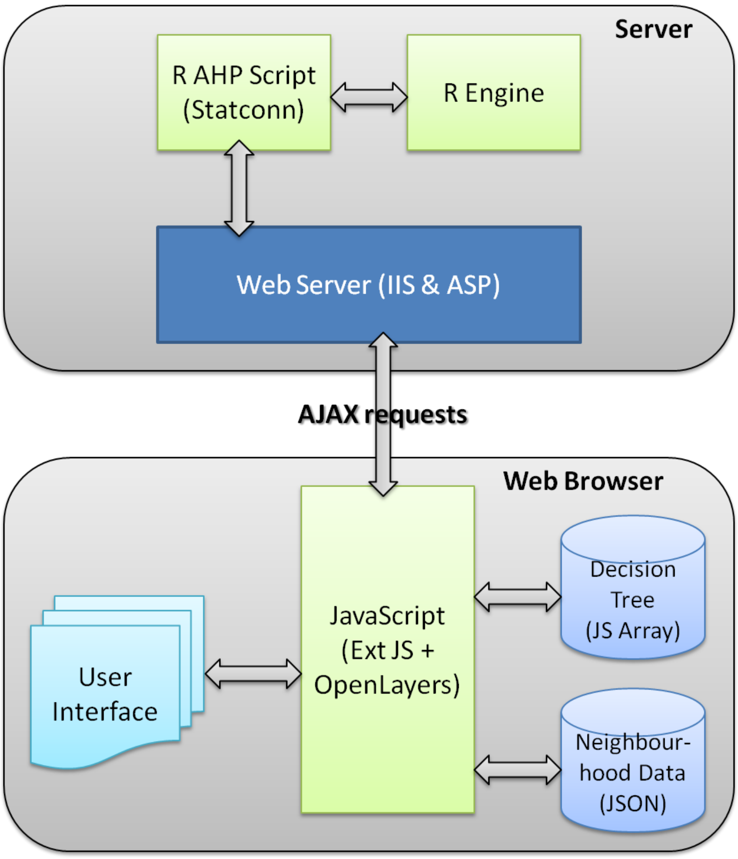


Figure 49: Prototype SDSS system architecture

The following section details the technological choices behind this infrastructure, both on the client and server sides.

8.2.4.1 Client-side development

In the past, the client component of a RIA would most likely have been developed using proprietary plug-ins, such as Adobe Flash or Microsoft Silverlight. These custom browser plug-ins offer advantages, such as speed, over dynamically compiled languages such as JavaScript, as well as potentially much richer functionality and user interface elements available out of the box. Although they offer potential for the development of internet applications indistinguishable from localised applications, they come with some drawbacks, which make them more akin to traditional software packages. Given that both Flash and Silverlight are commercial products based on proprietary and closed technologies, plug-ins for different browsers and operating environments are needed, limiting the deployment of RIA to clients to supported environments. They also pose more severe demands on client computers' processing speeds and memory, putting greater demands on the client's computers.

Improved web standards and compliance with these standards by most modern web browsers means that the need for browser plug-ins has diminished. JavaScript, supported by virtually all modern web browsers, is the main language used to implement RIA today. Modern implementations of RIA using JavaScript to implement client functionality and communicate asynchronously with a backend server using data exchange standards such as XML are commonly referred to as AJAX. Data is read from the server or sent to the server on a needs basis, minimising server delays and offloading user interface operations to the client instead of to the server in a strictly HTML web application. The framework is acting effectively as an intermediary between the user and the server, managing and optimising performance.

While the JavaScript language allows for the manipulation of the browser DOM and for richer interactive user elements and functionality without resolving to server call backs, support for such functionality is still only rudimentary. Frameworks of JavaScript libraries emerged to facilitate cross-browser compatibility, provide rich user interface elements, and support development, encapsulating frequently used functionality and user interface elements. Multiple AJAX libraries have been developed in the past ten years, including competing libraries from Google, Microsoft, and Yahoo[52].

For this project, ExtJS provides one of the richest set of user interface elements out of competing AJAX RIA frameworks, as well as good API documentation and a vibrant user community. Given these benefits, the choice was made to use ExtJS as the main development library to implement the client-side user interface and program logic. ExtJS enables accelerated development of the user interface elements needed to support the decision-making process, for example, by offering a readymade slider user interface element for the pair-wise comparisons. In addition, the management of the decision tree and the program logic allowing for the asynchronous generation of the absolute weights attached to the decision tree was made possible through ExtJS.

The geo-visualisation of London's neighbourhoods on an interactive map along with the ranked list of neighbourhoods necessitated the integration of disparate spatial and non-spatial datasets on the client side. This was facilitated by an extension to ExtJS, called GeoExt, which

[52] For example, companies such as Google have open sourced their internal AJAX libraries (Closure) that are used in Google's own RIA. YUI is another such AJAX RIA library, originally sponsored by Yahoo to implement new versions of their front page and mail web applications. It was subsequently open sourced and other developers started coding extensions for the library. One of the most significant extensions was Ext, which currently offers both a rich set of user interface elements and many internal functions, making the development of RIA much easier for developers.

enables the integration and display of spatial datasets in RIA developed using ExtJS. GeoExt relies on the OpenLayers JavaScript library for the display of geospatial data.

OpenLayers is an open source library allowing the integration and display of disparate spatial datasets, enabling the user to view and interact with the map data through a draggable and zoomable "slippy-map" web-mapping interface. Such interfaces were first pioneered by Google Maps in 2005 and have become the de facto standard interface paradigm for the display of spatial data using web browsers. Unlike Google's Maps JavaScript API or Microsoft's Bing Maps JavaScript API , OpenLayers is map data agnostic , i.e. it allows the use of different mapping providers including Google, Yahoo, Microsoft, and custom defined tile sets, according to TMS standards. OpenLayers also allows for the integration of separate vector datasets on top of a slippy map, as well as the query of vector attribute data. Such overlays with a raster tile-based map are often referred to as "mashups".

Given the need for the interactive display, exploration, and comparison of London's neighbourhoods, an appropriate base map had to be found. The base map acts as an orientation aid for the user and characterises the physical environment of London (roads, buildings, etc.). Most web map "mashups" use web maps from Google or Microsoft, but the cartography of these base maps poses visualisation issues when combining with ancillary data, such as neighbourhood centroids, outlines, and labels. A suitable base map tile set for London could have been developed specifically for the purposes of this project, with a bespoke cartographic design harmonising with the overlays planned, but given the prototype nature of the implementation, an alternative existing base map source suitable to the overlay of information was sourced from CloudMade's[53] web mapping tile sets.

[53] Available at http://map.cloudmade.com

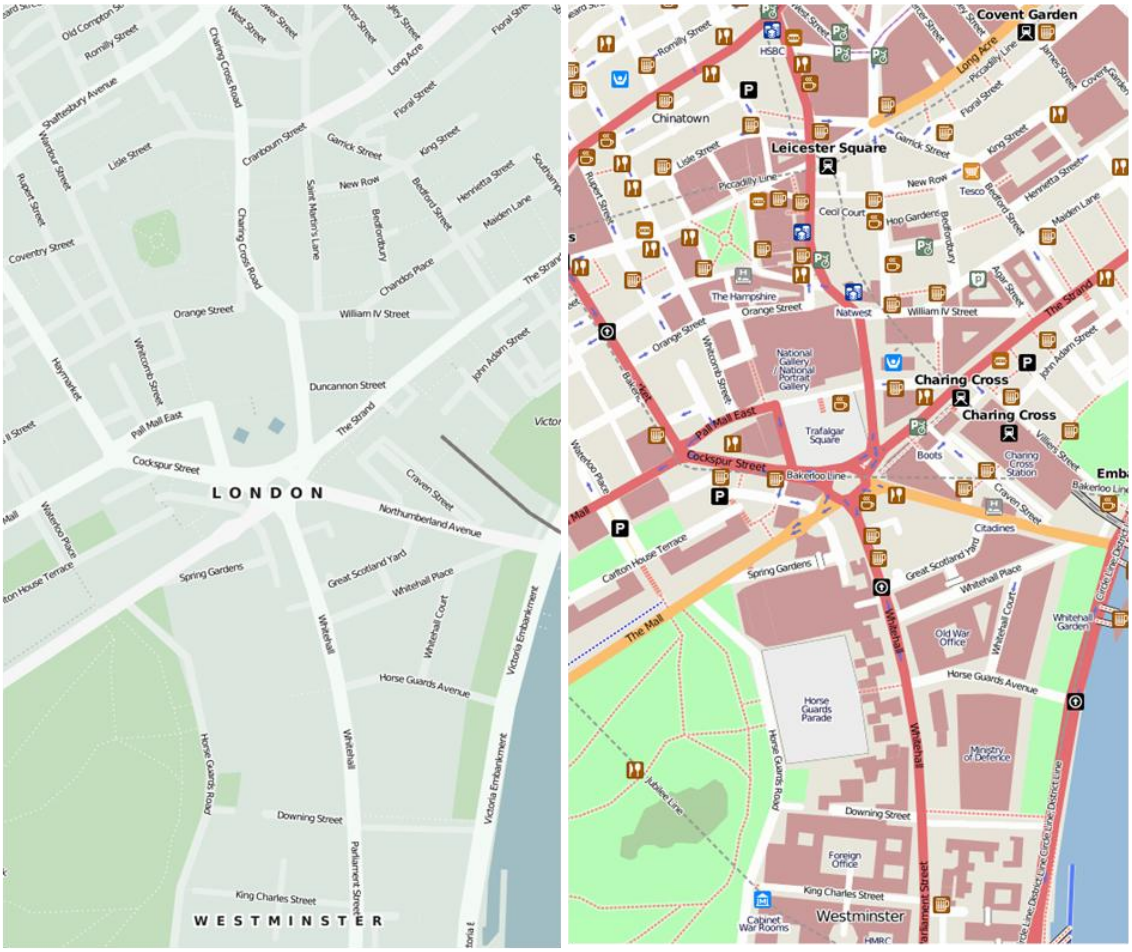


Figure 50: Comparison of Cloudmade map styles: customised style (left), default (right)

CloudMade is a company offering the novel ability for any user to generate base map tile sets with a customised cartography. Using a simple online tool, users can develop their own cartographies, using data sourced from the OpenStreetMap project. Many map styles are already defined and shared by the tool, and CloudMade renders tiles for each style and offers them as base map styles for integration in external web-mapping applications. The "Everyblock"[54] map style was chosen for this case study, with a cartographic style designed specifically to facilitate map mashups. An example of the cartographic style, next to a standard cartographic style offered by CloudMade, is given in Figure 50.

[54] Everyblock (http://www.everyblock.com) is a website presenting local news by location, which makes use of OpenStreetMap and a custom tile style similar to the one presented by CloudMade, designed specifically for mashup applications.

The geo-visualisation interface of the client also includes for each town centre a set of charts visualising the different geo-business environments in a spider diagram. These diagrams are generated on demand by the “Google Charts” API and displayed inside the client environment.

8.2.4.2 Server-side development

Although the browser based client-side provided almost all of the functionality of the whole decision-making process, the computation of the absolute weights from the pair-wise comparisons matrix, as defined in the canonical definition of AHP was implemented in R, a very flexible statistical computation environment, easily extended using packages which encapsulate custom functionality. The execution of the AHP algorithm, generating absolute weights from the pair-wise comparisons matrix, is a task ideally suited for implementation in the R environment. An indicative example source code of the implementation is given below:

```
#Canonical EigenVector Implementation of AHP
#generate input pair-wise comparison matrix
source <- matrix(c(1,0.333,0.14,0.11 , 3,1,0.2,0.14 , 7,5,1,0.33 , 9,7,3,1),
nrow=4,ncol=4)

#Create EigenValues and EigenVectors of source matrix
sourceEigen <- eigen(source)

#As Eigen function output is ordered high to low,
#the principal EigenValue is the first element
pEigenValue <- sourceEigen$value[1]

#The principal EigenVectors are also in the first Column
pEigenVector <- sourceEigen$vectors[,1]

#Normalised prinicipal EigenVector (scores)
scores <- pEigenVector / sum(pEigenVector)

#Generating the Confidence Index
CI <- (pEigenValue-nrow(source))/(nrow(source)-1)

#The Random Consistency Index, as taken from Saaty
RI <- c(0,0,0.58,0.90,1.12,1.24,1.32,1.41,1.45,1.49)

#The Consistency Ratio, should be below 10%
CR <- CI/RI[nrow(source)]

#Final Results:
#Scores:
scores

#Consistency:
CR
```

In the context of the prototype implementation, R and ASP thus constitute the server-side computation engine of the RIA. The client sends a pair-wise comparison matrix using an asynchronous XML request to the web server (Microsoft IIS web server with Active Server Pages). A server side script then processes the matrix received, handing over the matrix to R[55],

[55] Using “statconn”, a library enabling the interaction between R and external Windows software packages, the computational power of R can be harnessed from many external development environments. Statconn enables the interaction of R with web servers such as IIS, enabling the usage of R from the systems web server.

which processes the matrix and generates the absolute weights and Confidence Ratio. The ASP script then returns the resulting decision tree with absolute weights and Confidence Ratio as the answer to the asynchronous request to the client script, which processes and updates the ranked list of neighbourhoods accordingly.

8.2.5 Finalised prototype

The final prototype implemented is presented to the user as a website, subdivided into two parts using tabs: a questionnaire, which gathers the location preferences of the user and a map interface allowing the user to explore the ranked neighbourhood list using a web-mapping interface.

The definition of the location preferences by the user is achieved through a questionnaire (see Figure 51) subdivided into three window tabs to guide the user through the process. This is done using sliders that also indicate the relative weight of the pair-wise comparison, i.e. Variable A is moderately/strongly/very strongly/extremely preferred to variable B, or vice versa. The first tab of the questionnaire holds the 36 pair-wise comparisons for the neighbourhood classes, the second tab contains one pair-wise comparison for the accessibility measures, and the third tab holds one pair-wise comparison of the importance of neighbourhood characteristics versus accessibility overall[56]. Once the user has completed the questionnaire, he can click on the second tab element of the prototype website, which takes him to the web-mapping interface.

[56] To facilitate debugging of the prototype, the variable weights are computed and recorded by the server as the user progresses through the location variables questionnaire. The decision tree thus is continually updated with the computed absolute weights. For the user testing experiments, the display of the decision tree and attached weights was disabled, to not influence the pair-wise comparisons by the user.

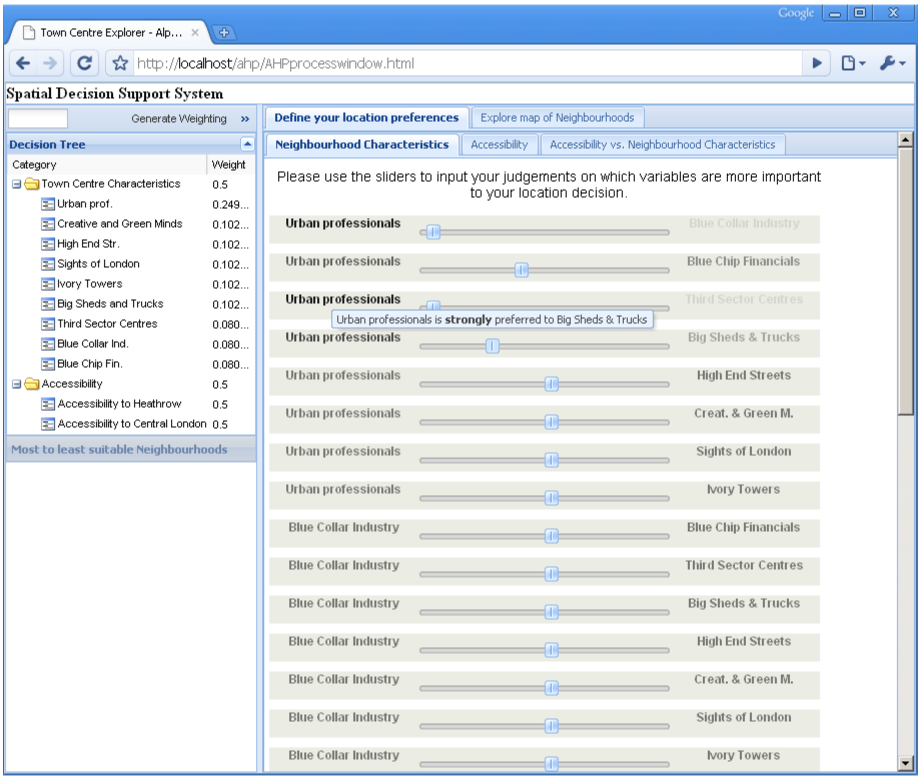


Figure 51: Screenshot of the final prototype pair-wise comparison interface

In the web mapping interface (see Figure 52), the user is presented in the left-side portion of the screen with a tabular list of London neighbourhoods, ranked from most suitable to least suitable, according to his individual location preferences. The map interface contains a map of London, overlaid with centroid markers of all London neighbourhoods. A secondary option also allows the user to show or hide the actual neighbourhood boundaries (as defined by the London town centres dataset). The map and ranked list of neighbourhoods initially displays the most suitable neighbourhood. Individual items in the list can then be expanded to reveal a radar chart of the individual geo-business class scores attached to the given neighbourhood, allowing the user to gain a better understanding of the geo-business makeup of a given neighbourhood. In addition, the actual travel times representing the accessibility indicators are displayed. The user is then free to browse the map and list. If he selects another neighbourhood in the list, the map is automatically centred on this new neighbourhood, and the neighbourhood list item expanded to show detailed information.

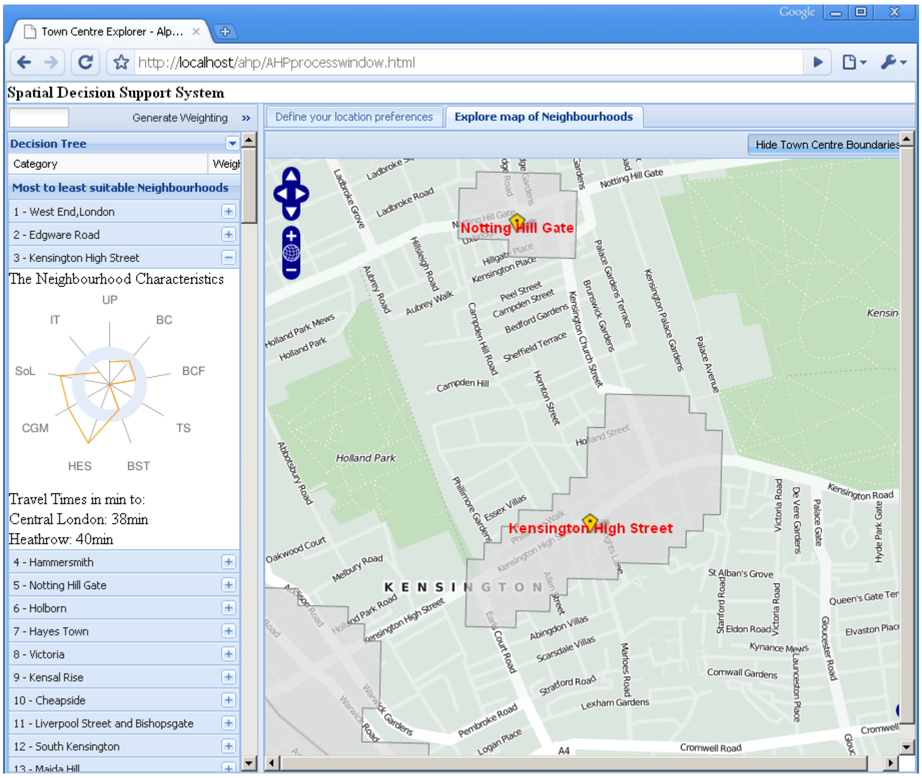


Figure 52: Screenshot of the final prototype system map interface

The user is then free to explore and compare the ranking of neighbourhoods, comparing neighbourhood characteristics according to visualised data regarding geo-business characteristics and accessibility. The process can be iterative, and the user is free to change his pair-wise choices and evaluate the impact this has on the neighbourhood ranking.

8.3 System evaluation

Throughout the development process of the prototype, informal feedback on functionality and usability from both users and external advisors was sought and fed back to the implementation work. However, a separate more formal user evaluation process was needed to: (1) investigate and prove the business benefits of the novel presentation of London business neighbourhoods supporting location decision-making; and (2) evaluate the validity and consistency of location recommendations. In other words, do users, given the same information, making use of the same database and decision support tools, arrive at similar conclusions? This investigation then allows the evaluation and validation of the developed approach to business location decision-making support. The general usability of the interface is also considered in the evaluation exercise as valuable feedback for the improvement of the prototype implementation towards eventual deployment.

8.3.1 Evaluation design

Through the informal feedback process set up during the development process, an empirical and observational framework of the prototype system emerged. Such a framework has been characterised as formative evaluation (R. W. Tyler et al. 1967; Bowman et al. 2002) and relies on a continual evaluation process lying on a continuum ranging from informal, such as comments from users or general reactions to incidents, to more formal evaluation processes producing qualitative and quantitative information. The implementation phase of the prototype system already took account of such informal formative evaluation techniques through continued feedback sought from users and fellow researchers, adapting the implementation according to user needs and feedback.

The formal gathering of more qualitative and crucially quantitative data on the consistency and validity of the chosen data and methods implemented in the system necessitated a separate exercise of data gathering. In HCI, usability testing often implements such tests for users to record quantitative data in terms of, for example, timings and number of errors. The next section details the design of the user evaluation exercise, including the choice of participants, design of the exercises based on scenarios, and the design of a post-task questionnaire.

8.3.1.1 Participants

Based on prior experience gained in the context of the GIS user requirements study for Think London, hypothetical user profiles or “personas” representing likely users of the proposed GIS system, were developed. These “personas” also represent likely user groups of the proposed SDSS: (1) Business Development Managers, (2) Regional Representatives, (3) Market Researchers, (4) Marketing Team Members, (5) Executive Managers and (6) outside users, including web site visitors and potential investors. These profiles also proved useful in guiding the selection of users most likely to use the finalised version of the prototype business location decision support tool. Business Development Managers, as well as Regional Representatives and Market Researchers, were identified as potential users of the system, representing the primary points of contact with FDI investor clients. Marketing Managers and the Executive team were not considered to be primary users of a final system, as they are not in direct contact with FDI clients.

Five users from the business development and market research team were selected for the user evaluation study[57]. This group was chosen to give feedback primarily on the prototype recommendations and validity as a tool to help business location decision-making. Another group of five experts from UCL's academic community were chosen to represent non FDI experts, but with a solid understanding of spatial socio-economic and business datasets, geodemographic analysis, and exploratory data visualisation experience.

8.3.1.2 Scenarios

The aim of every usability test is that *"test participants attempt tasks that users of the product will want to do with it"* (Dumas & Redish 1999, p.160). Given this premise, the careful design of a relevant set of task is essential to obtain worthwhile results. Three scenarios were chosen, based upon real FDI problems Think London have tackled in the past. Each scenario listed information on the company plans for investment into London, including their required location characteristics. Users were asked to "play" the scenarios and use the prototype to try to find the best location given the information contained in each scenario. By recording the outcomes of these scenarios, specifically the absolute weights attached to individual location variables, outcomes between users could be compared to determine if there was consensus between users on the importance of different location variables.

The scenarios are based on real past Think London clients that established presences in London (also called "completions"). Completions were gathered from the completions database, which holds a free-form description of each completion, describing in varying detail various aspects of the project, such as how the lead was found, if the project was contestable with other out of London locations, what Think London did to help the company, what the relevant issues were to the company, and the final implementation location for the company.

From an initial list of approximately 20 potential case studies, a final selection of three case studies was made based on the detail of the description of location variables relevant to companies, as well as the final diversity of location variables. The case studies were anonymised and the descriptive text was adapted to ensure that sufficient information about

[57] The justification for the sample size to evaluate functionality and usability of the prototype system can be found in previous research by Nielsen (2000), who claims that small tests with 5 users are more than sufficient for the discovery of most problems. The number of people was also restricted to the likely minimum necessary to obtain significant results given that only one person organised the study, conducted the tests, and analysed the results.

location variable relevance was contained to inform experiment participants. The final three scenarios used in the user evaluation study are listed below:

> ***Scenario 1:*** *You are the representative of a leading international company running a group of laboratories providing a range of testing and support services to the pharmaceutical, food, environmental, and consumer products industries, and to governments. Your company is looking to expand into the UK and wants to open their first lab, as well as a sales and marketing office, in London in order to connect to the local food manufacturing and distribution companies within the wider London area. There is no need for representative offices, you are rather looking for second-rate locations where you can get a good deal on the rent and be close to your clients' factories and warehouses, from which your lab will receive the food samples. You also need to recruit a number of lab workers and scientists with experience of lab work in the life sciences sectors.*

> ***Scenario 2:*** *You are the representative of one of the top ICT companies in India. You are looking at London to set up a European headquarter and sales and marketing office. Given that your parent company is located in India, you are looking for a location within easy reach from Heathrow. Although you have already considered Reading, where you have a software development centre, the main driving factor for your location decision is proximity to your customer base in London. Your key clients in London can be found in the finance & insurance industry, primarily located in Central London, along with telecom industry sectors and public sector bodies. You will need representative offices to host client meetings, within easy reach of your clients in London, that are also accessible to other transport infrastructures, such as the Eurostar.*

> ***Scenario 3:*** *Your company is a design consultancy dedicated to improving the way people interact with technology and environments. You design, build, and test computer interfaces, for example to enable technicians to monitor energy networks and dispatch emergency services, as well as financial trading platform interfaces. Your company is looking to set up a sales and marketing office for the UK, establishing contacts in the creative industry and ICT sectors in London. As most of the actual work will be done in the main development centre in San Francisco, you will also need offices that are accessible from Heathrow.*

8.3.1.3 Experiment design

The experiments with the ten chosen subjects each lasted one hour. The experiment facilitator guided the individual participants through the experiment, observing the experiment, noting user comments, answering user questions, and helping users navigate the prototype system. The experiment consisted of several sequential stages:

1. **Context of research:**
   First, a brief context of the research project was given to the user, detailing the overall research project aims and objectives and the reasoning for the development of the prototype system. Some of the limitations of the prototype implementation were explained to the user, for example the focus on a defined subset of location variables relevant to investment location decisions, excluding variables such as co-location to competitors, suppliers partners, as well as the exclusion of property offer and price considerations. An overview of why and how the geo-business classification was built was given. Each geo-business class was presented in turn to enable the users to understand the differing characteristics. The users were given a handout detailing the nine geo-business classes.
2. **Presentation of task aim:**
   The users were given the task of reading the first scenario. Each user was asked to put themselves in the place of the potential investors and identify the requirements for the ideal business location based on information provided in the scenario.
3. **User runs through questionnaire:**
   The users were asked to run through the web client, aided by the facilitator, to learn how to use the pair-wise comparison sliders. The users went through the decision hierarchy pair-wise comparisons, using the scenario information and geo-business classes' handout, to evaluate and express preferences using the pair-wise comparisons between the geo-business classes. After the geo-business classes, the users compared the accessibility measures, finally entering their judgments on the importance of accessibility versus the geo-business classes.
4. **Evaluation of ranked neighbourhoods:**
   Once each user was satisfied with the pair-wise comparisons, they moved on to the geo-visualisation interface to evaluate the ranked neighbourhood recommendations. Users explored the top five neighbourhoods using the interface. Any comments by the

users regarding the ranking or perceived suitability of the individual neighbourhoods were recorded by the facilitator.

This process was repeated for each of the three scenarios.

During the scenarios, the experiment facilitator recorded general comments made by the participants, and asked the users to express their opinions on the appropriateness of the results, particularly whether there were any surprises in terms of choice of neighbourhoods. Comments were captured in free-hand form and subsequently transcribed to a log sheet.

Once the three scenarios were finished, the experiment finished with a set of questions asking the user to detail his opinions on the following questions:

- Do the neighbourhood class descriptions make sense and are they useful? If not, why not?
- How relevant were they to your decision-making? Did they provide enough information to make a decision?
- Did you find the pair-wise comparisons to be a useful way to prioritise location variables?
- Do you think that the results are relevant to the problem, and do they make sense? Were you surprised by the results? Why?
- Was there sufficient information in the output to enable you to understand and compare different neighbourhoods?

General comments not classifiable into one of the questions were recorded separately. Such comments also included comments about the usability of the interface.

The prototype system itself recorded the pair-wise comparisons as they evolved based on the user input, as well as the final weights attributed to each location variable. The relevant data was saved as simple text files for each participant on the server side of the application. Each user ran through the scenarios in their own time, with each scenario taking approximately 15 minutes to complete. After the three scenarios were finished, a final qualitative questionnaire was used to elicit more general feedback.

8.3.2 Analysis of evaluation results

The following section reviews and discusses general user comments regarding the prototype system, followed by a quantitative analysis of the numerical outputs recorded for each user and scenario, investigating the robustness of the decision making process when comparing individual users' subjective judgments and outcomes.

8.3.2.1 Qualitative analysis

The analysis of the qualitative comments recorded during the experiments and during the debriefing questionnaire provide a rich data source of first hand observations from real users on the ease of use, the relevance and validity of both the model and process, and some tentative comments on the usability of the tool. The feedback was recorded, and comments for both user groups are summarized in Appendix 11.6.

The user feedback from the geo-business classification presented to users before the scenarios to familiarise themselves with the different classes also brought up some comments. Generally accepted to be useful as a starting point to understand the type of business environment a client might be attracted too, some users commented on the similarity of "Urban Professionals" vs. "Blue Chip Finance". One user commented on the subjectivity of the descriptions, for example of the pejorative description of "Third Sector Centres" as having low value office space, versus the possibility of a more positive description of inexpensive office space, highlighting the inherent subjectivity in the qualitative description of the geo-business classifications.

The feedback from users regarding the initial pair-wise comparison process indicated that it was intuitive, even though some commented on the large number of pair-wise comparisons needed for the evaluation of the geo-business classes. Some users expressed concern for the weights resulting from the AHP process, specifically of accessibility versus neighbourhood characteristics. In the case of the pair-wise evaluation of these two variables, the absolute weights resulting from one judgment seemed to users to be too extreme, i.e. "strongly preferred" resulting for example in a weight of 83%, a weight that they thought didn't match their mental model of and definition of "strongly". Users felt that the nominal assignments (slightly, strongly, very strongly, extremely) and the attached weights, as implied, did not correspond to the absolute weights assigned to these textual meanings.

The top ten recommendations provided by the tool for each of the three scenarios and based on the user inputs were mostly accepted to be relevant, although there was a tendency to find the results from the first scenario to be less relevant. A few users commented on the possibility of not presenting to the user an absolute top to bottom ranking from most appropriate to least appropriate recommendation, but instead classifying town centres into groups deemed, for example, to be “highly suitable,” “somewhat suitable,” or “unsuitable.”

When asked for feedback on the visualisation of the location recommendations, users tended to note the absence of contextual and more in-depth information about given neighbourhoods. Users noted the absence of more statistical information about the size of town centre, data from the constituent variables of the geo-business classification, more information on local accessibility, and the integration of live property offers. Some users commented on the lack of overview maps showing the distribution of given geo-business environments over the whole of London, as well as user interface issues such as the inability to have more than one town centre profile open at the same time.

8.3.2.2 Quantitative analysis

The qualitative analysis of user comments provides an overview of the user experience of the system and decision-making process, validating overall the proposed location recommendations. This section will specifically address the suitability for business location decision-making of both the data framework and AHP as a consistent and robust model of business location preference and trade off processes. In other words, do users, given the same information, making use of the same database and decision support tools, arrive at similar conclusions? This analysis entails both comparing the results between users’ in a given group (intra-group analysis) as well as the inter-group analysis of consistency between the two groups of FDI experts and UCL academics.

The following quantitative analysis is made possible by datasets gathered automatically by the system during each scenario. For each user and scenario, the system recorded both the input decision matrix, i.e. the pair wise choices, output decision hierarchy and resulting weights attached to individual variables, as well as the final weighted TC suitability score and location suitability ranking. The server also saved ancillary information identifying the user, scenario, and date & time. These detailed logs enable the following qualitative analysis of the decision-making processes of the individual users.

8.3.2.2.1 Inter-group analysis

One question regarding the design of the evaluation study and participant choice is if study outcomes are influenced by participants’ previous FDI experience or lack thereof. If outcomes are significantly different, this would mean that expert and non expert users interpreted the information contained within the scenario descriptions differently, thereby affecting the outcomes of the experiment. Such bias is deemed undesirable as the study is designed to test the decision support offered by the system, with each user given the same scenario, not the prior knowledge of FDI of the participants.

A suitable test to determine such significant differences between the two participant groups is the t-test of independent samples for each scenario, applied to both the weights attached to individual variables as the outcome of the AHP process, as well as the system's location recommendations in the form of the weighted index score. The independent two samples t-test determines if the means are significantly different between the two participant groups, indicating differences in outcome between the two groups. The detailed t-test results tables can be found in Appendix 11.8 – "T-test statistics for geo-business variable weights", and Appendix 11.9 – "T-test statistics for location recommendations". In both cases, the accessibility variables were excluded from the analysis.

The independent samples t-test of the geo-business variable weights compare for each scenario the geo-business classification variable weights between two user groups. Using the "Levene test" for equality of variances, for all three scenarios, the variance of each group is deemed equal (Levene test $p > 0.05$). Although the validity of the tests is reduced by the small sample size, the results for all three scenarios fail (two-tailed $p > .05$) to reveal a statistically significant difference between the mean scenario location variables weights of the two groups. In other words, there is not enough evidence for a statistically significant difference in the geo-business variable weight outcomes between FDI expert and non-expert participants for all three scenarios.

The t-test for independent samples can be repeated for the weighted index scores associated to each TC (208 variables), from which the suitability ranking is generated for the user. Once again the "Levene test" for equality of variances, for all three scenarios indicates equal variance between the groups (Levene test $p > 0.05$), this is again dependent on a small sample size. The t-test for all three scenarios fails (two-tailed $p > .05$) to reveal a statistically reliable difference between the mean TC weighted index scores of the two groups.

The conclusion then is that there is not enough statistical evidence to confidently reject the null hypothesis, which is that no difference exists between the two sets of user groups: FDI expert and non-expert participants for all three scenarios. The power of the tests unfortunately is reduced by the relatively small sample size (n=10). Although a larger user testing campaign would contribute more robust statistical results, in the context of this limited prototype evaluation, there is enough evidence to validate the study design to test the decision-making process and outcomes, regardless of the level of prior experience in FDI participants may have.

8.3.2.2.2 Intra-group analysis

Apart from the evaluation of the two user groups in aggregate, a more detailed look at individual participant's decisions consistency inside both groups is required.

AHP as a MCDM methodology specifically allows users decision-making to be inconsistent[58]. The consistency of a participant's pair-wise comparisons, and thus resulting decision hierarchy weights, is expressed by the Consistency Ratio (CR) (see Appendix 11.5.3.2 – "Consistency measurement" for details of its generation). As defined by Saaty (1990), if the CR is below 10% (0.1) the inconsistency of the pair-wise comparisons matrix is deemed acceptable. The consistency ratio can only be calculated for AHP models, which compare more than two variables, so the CR is constrained to only the geo-business classification preferences section of our decision-making model. Table 18, shows the CR for all ten users and three scenarios, along with the averages for each user, and overall average per scenario. The CR's for most participants was around or above the accepted threshold for consistency.

Table 18: Consistency Ratios for different users and scenarios

User ID	Group	Scenario 1	Scenario 2	Scenario 3	Average
1	**UCL**	0.14	0.09	0.11	**0.11**
2	**UCL**	0.28	0.16	0.07	**0.17**
3	**UCL**	0.08	0.05	0.09	**0.07**
4	**UCL**	0.13	0.18	0.24	**0.18**
5	**UCL**	0.09	0.18	0.20	**0.16**
6	**TL**	0.08	0.13	0.13	**0.11**
7	**TL**	0.08	0.04	0.06	**0.06**
8	**TL**	0.04	0.17	0.16	**0.12**
9	**TL**	0.13	0.17	0.16	**0.15**
10	**TL**	0.06	0.10	0.09	**0.08**
	Average	**0.11**	**0.13**	**0.13**	

[58] Consistency in this context is defined as the transitive property of the preference logic. An example would be where a user is asked to express his preferences of three different fruits: If the user strongly prefers bananas over apples (A < B), and also prefers apples over cherries (A > C), then he should logically also prefer bananas over cherries (B > C). His pair-wise comparisons would be inconsistent if he preferred cherries to bananas.

Going back to the comparison of the two user groups, t-test of independent samples were run (see Appendix 11.7 – "T-test statistics of Confidence Ratio" for detailed results) to determine if there was a significant difference in the consistency of judgments between FDI expert and non-expert participants (i.e., the UCL vs. TL group). The variance of the CR between the two groups is deemed comparable (Levene test $p > 0.05$). The t-tests for all three scenarios aggregate CRs' fails (two-tailed $p > .05$) to reveal a statistically reliable difference, i.e. there is not enough evidence for a significant difference in the consistency of judgements between FDI expert and non-expert participants.

Apart from the analysis of the consistency of the two user groups, the scenario outcomes (i.e. the weighted index value for each TC generated from the weights, from which the location recommendations were generated, can also be investigated for consistency. If the scenarios present relevant information, and the data framework and decision process enables users to efficiently enter preferences based on those scenarios, than the outcomes given the same information should be similar. To test this hypothesis, cross-tabulation tables for each scenario and user group were generated with the Pearson's Correlation (*r*) index, using the TC weighted suitability scores, taking into account the geo-business environments component only (see Appendix 11.10 – "Pearson's correlation index of location recommendations" for cross tabulation tables of the correlation indexes). The results show convincingly for all three scenarios and user groups significant correlations between outcomes, indicating broadly similar results from each user, regardless of prior level of knowledge of business location decision-making.

In conclusion, the investigation of the two user groups shows no significant differences in terms of both outcomes, as well as consistency of judgments, regardless of ability or prior knowledge of the participants. The design of the evaluation study thus validates the potential for decision support offered by the system, independent of individual user characteristics.

8.3.2.2.3 Scenario Analysis

The analysis of individual scenario outcomes can also be done graphically by visualising the absolute weights decision tree, generated from the pair-wise comparisons. In these plots, the mean importance of each variable for all users is compared against the outcome variation, i.e. disagreement between participants. Specifically, these two variables then are:

- **Importance**: Average weight attached to the different location variables represents the importance of a location variable, on a scale from 0 to 100 percent, as determined from the final scenario outcomes recorded by the web server.
- **Disagreement**: The standard deviation is a standard measure of dispersion of a dataset, and represents here a measure of disagreement between individual users' outcomes.

The two measures can be plotted to determine patterns of agreement/disagreement, or consistency of decision-making between users. A convenient way of modelling importance and disagreement is a X-Y plot matrix, with the standard deviation on the X axis, and average importance on the Y axis. This matrix is subdivided into four squares representing:

- Variables considered unimportant by all users (**low-low**);
- Variables considered by all users to be important (**low-high**);
- Variables that are on average considered to be important, but where there is considerable disagreement over the importance (**high-high**);
- Variables considered on average to be unimportant, but with disagreement when comparing individual users' preferences (**high-low**).

The next section only processed the weights attached to the nine geo-business classes, omitting the accessibility aspect of the decision-making. Accessibility was only considered indicative of the potential of AHP to integrate multiple levels of decision-making. Only two accessibility variables were included, resulting in only one pair-wise comparison to determine the weights, which also means that no meaningful CR can be generated[59].

[59] The problem of inconsistency does not arise, as one pair-wise comparison is always consistent in itself!

8.3.2.2.3.1 Scenario 1

For scenario 1, the plot reveals a structure to the graph. On the bottom left (i.e. the low importance and low disagreement quadrant,) there are a set of variables that were deemed irrelevant to the scenario by most users. “Urban Professionals” is more interesting, because even though the average importance is not significantly higher than the rest of the deemed unimportant neighbourhood characteristics, there seems to be considerably higher disagreement.

Next, there is a group of three neighbourhood characteristics (“Big Sheds and Trucks”, “Blue Collar”, and “Ivory Towers”) that have considerably stronger average importance, but there is also considerable disagreement. These neighbourhood characteristics are generally considered to be relevant location variables for Scenario 1. “Urban Professionals” on the other hand, seems to be more contestable as a relevant neighbourhood characteristic deemed attractive for Scenario 1. Further research would be needed here to see what made some users disagree with others about the importance of this characteristic.

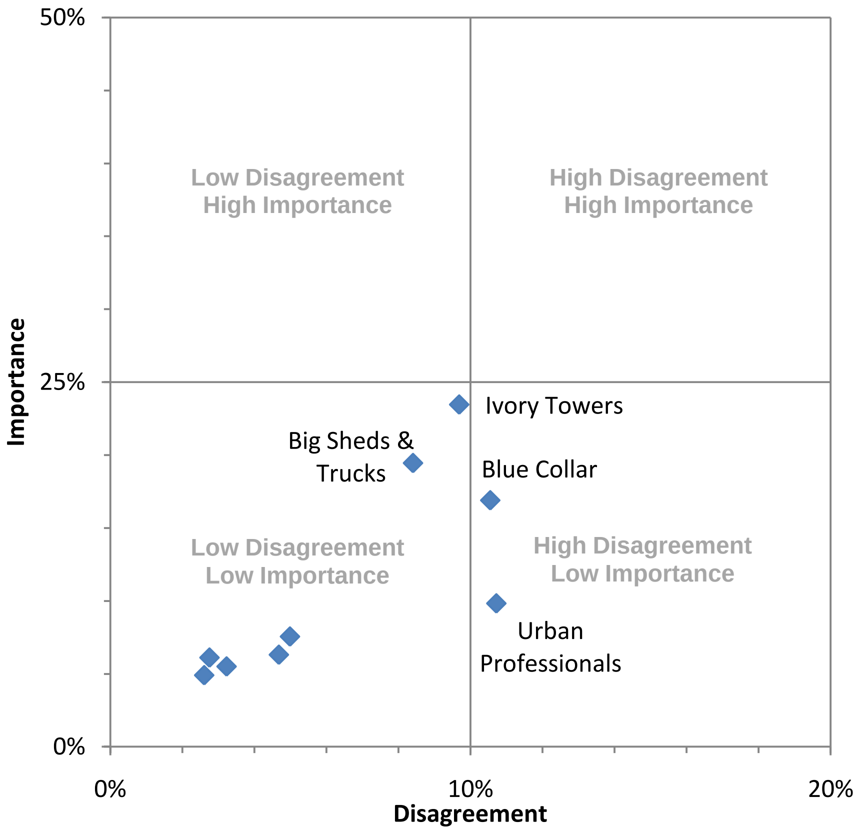


Figure 53: Importance/Disagreement matrix for scenario 1

8.3.2.2.3.2 Scenario 2

Scenario 2 repeats the pattern from scenario 1 in as much there is a clear distinction between a set of neighbourhood characteristics deemed unanimously irrelevant and four other location variables. Both “Urban Professionals” and “Blue Chip Financials” are deemed to be vastly more important than the rest of the location variables. They also possess disagreement scores of less than 10%.

This scenario possesses some of the lowest disagreement scores, and thus seems to be the most coherent in terms of consistency of how users judged the scenario.

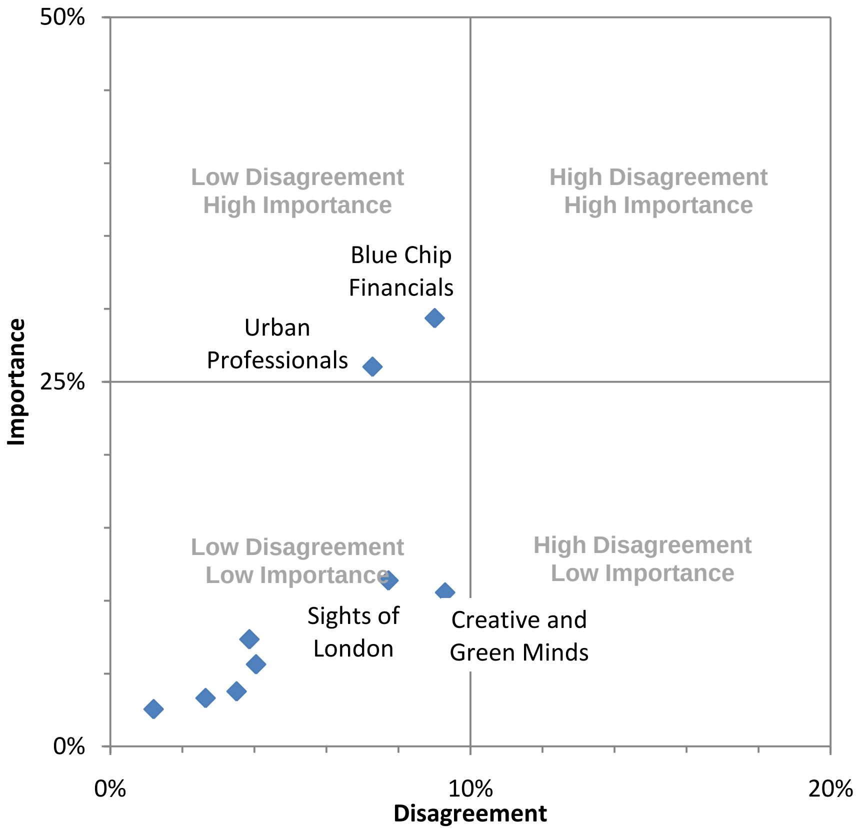


Figure 54: Importance/Disagreement matrix for scenario 2

8.3.2.2.3.3 Scenario 3

In scenario 3, a set of location variables deemed unimportant and with low disagreement can be distinguished. They obviously are considered unimportant in the decision making process at hand. Both "Blue Chip Finance" and "Ivory Towers" are deemed somewhat more important on average, but have moderate disagreement scores. "Creative and Green Minds" come out on top with regard to importance, but also had the most variation, with a disagreement score (standard deviation) of 13%, followed by "Urban Professionals".

This scenario has the highest disagreement scores, and thus seems to be the most contentious scenario.

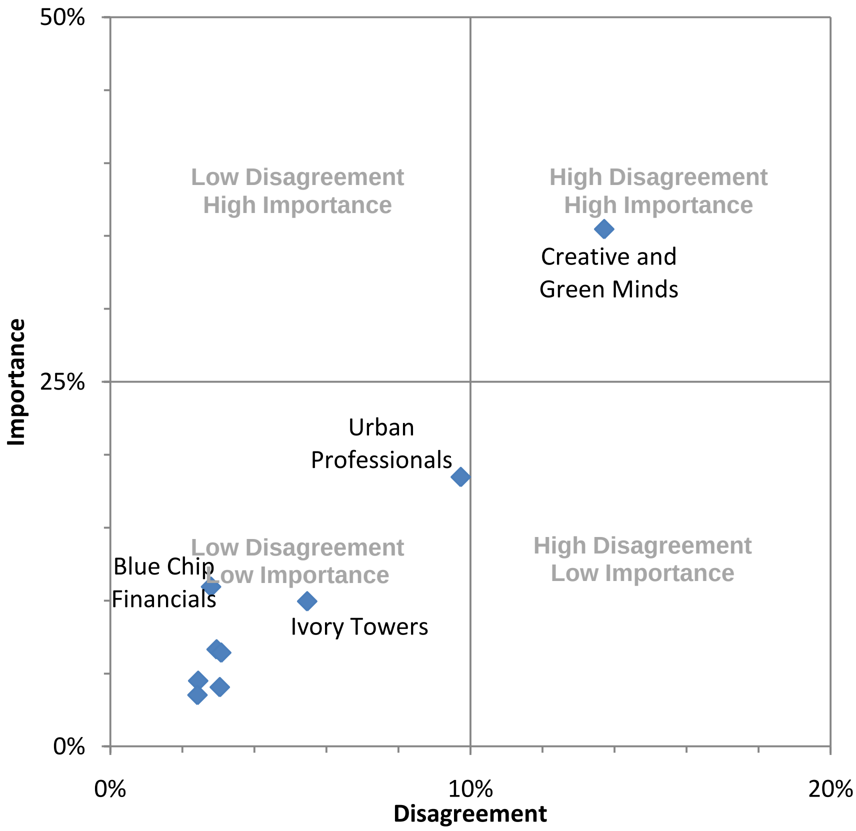


Figure 55: Importance/Disagreement matrix for scenario 3

8.3.2.3 Discussion of evaluation results

The evaluation of the different scenarios outcomes across users enables the assessment of the robustness of the decision-making process when comparing individual users' subjective judgements. Overall, there is clear evidence for the potential of decision support in business location decision-making.

The statistical analysis of the outcomes, both in terms of geo-business weights and location recommendations, shows that performance between the two groups was similar. Users, given the same information and regardless of their prior level of knowledge, are able to come to similar conclusions on the weight allocated to location variables, resulting in similar location recommendations from the system. The detailed analysis of the weights generated by users for each scenario highlights the presence of two processes when evaluating neighbourhood characteristics. Firstly, all users seem to identify for each scenario a set of neighbourhood characteristics that are not relevant and score low on both importance and disagreement. Secondly, a small set of geo-business classes are deemed on average more important than the first group of neighbourhood characteristics, however these neighbourhood classes also then tend to have higher disagreement scores. Individual users' judgement on the exact degree of importance of a variable tends to be more contentious and variable than the decision if a neighbourhood characteristic is relevant or not to the case study.

For scenario 3, the participants seem to be less consistent with their decision-making in terms of the Confidence Ratio and in terms of disagreement scores. One can speculate that users might have been tired by the third scenario and made less conscientious decisions when pair-wise comparing characteristics, resulting in less clear results. Clearly, there is scope here for further research into the usability and cognitive limits of users when going through a complex decision-making process and being asked to make numerous pair-wise comparisons.

There also is tentative evidence from the qualitative evaluation of user feedback that both expert and non-experts agreed that the system enabled a more efficient exploration of London's business neighbourhoods, highlighting relevant location alternatives. However, the practical limitations of the evaluation campaign meant that no real investors looking to setup in London were included in this study. Clearly, further work on the system will need to include an evaluation campaign including "live" investment projects. Such a study would be able to support business location decisions, evaluate the practicality of the proposed decision support database and environment, as well as better quantify the relevance to investors of location recommendations.

8.4 Discussion of prototype SDSS

The implementation of the prototype SDSS served primarily as a demonstrator for the potential of decision support in the context of business location decision-making. The combination of the database component defined by the geo-business classification, with a relevant decision model base formed by AHP can only be achieved through the implementation of an efficient computation environment. The development of the computation environment, based on a modern web server – browser client paradigm, performed well in the user scenario testing, allowing the efficient interaction between system and the user (base component). Subsequently, the scenario based evaluation showed that the prototype enables the capture and processing of user's location preferences and trade-offs, presenting location recommendations in a geo-visualisation interface, enabling potential investors with little prior knowledge of London's diverse business neighbourhoods to explore and compare different potential business locations.

The scope, benefits and limitations of both the geo-business classification database as well as of the AHP model base also apply to the prototype implementation. These limitations include: source data limitations in terms of quality, quantity and scope; limitations of the chosen geographic framework excluding business and industrial parks; methodological limitations of AHP including the complexity of pair-wise comparisons; the choice of an effective standardisation method of the constituent location variables; and the computation of location recommendations. The implementation and evaluation demonstrated that even given these limitations, the system is suitable for the intended purpose and allows the evaluation of the research methodology proposed in this thesis.

The implementation of the prototype system gave only limited consideration to the usability of the system, as well as the rich visualisation of the location recommendations. Even though the prototype system presents a minimal interface, this was sufficient for a fully functional implementation and evaluation of the decision making process, from the interface to capture user's preferences, to the visualisation of the location recommendations on a basic web mapping interface, with some basic graphs enabling the exploration of location options.

The user evaluation of the system highlighted some user interface issues, which can be attributed first to the nature of the AHP methodology. The number of pair-wise comparisons necessary for the computation of absolute weights was deemed overwhelming by some users when evaluating nine geo-business classes against each other. Clearly, the need to find ways to further reduce or subdivide the location variables is evident if one wants to include more variables at a later stage or allow users to construct their own decision hierarchies. Another observation is that there is scope for further guidance of the user through the AHP questionnaire, highlighting how many choices there are left to make, or giving some other indicator of progress, a feature widely seen in other online surveys.

Some users raised the issue of an absolute ranking of locations from most to least suitable. Subdividing town centres into groups according to suitability, without identifying their exact rank, possibly offers a more nuanced and less contentious way of presenting location recommendations, forcing users to investigate and compare locations more independently, instead of relying on the ranking to identify the most appropriate location.

The visualisation of the location recommendations was, in the context of the prototype implementation, limited in scope, delivering a rough but functional environment enabling the comparison of different location options through a basic visualisation in a radar chart of the geo-business make up of a given Town Centre. From user comments, the lack of further contextual information about the recommended Town Centres was deemed a drawback. Information about the absolute economic or population size of Town Centres, data from the constituent variables of the geo-business classification, more information on local accessibility, as well as a live property offer feed were all requested to enable users to gain a better understanding of the nature of different location options. A richer visualisation making use of different graphs, plots, and charts to communicate more information, along with contextual information, such as “Google StreetView” panoramic street scenes enabling an investor to virtually explore an area, all would have contributed to the better understanding by users of the “*feel*” of an area.

8.5 Conclusion

The implementation of the prototype SDSS represents the pinnacle of this research project, as it brought together the principal elements fulfilling the goal of developing a SDSS, implementing the four main components outlined previously through the research framework. The system integrates the previously disparate components: **database** in the shape of the input variables as defined by the geo-business classification and accessibility measures; the AHP **model base** capturing and processing the location preferences and trade-offs; an efficient server-client **computation base**; and the **user (base)** interface component enabling the efficient interaction between SDSS and user. The potential of this framework for business location decision support was explored through a scenario based user evaluation, focusing on the consistency of outcomes for both expert and non-expert users, as well as general comments from users on the usability of the system. The results of this evaluation confirm that the system presents a relevant and consistent environment to support business location decision support, integrating disparate datasets, methods and tools.

The benefits of such a system for potential FDI investors going through a location decision-making process with the help of the SDSS include a better understanding of both their location preferences and London's diverse business neighbourhoods. Specifically, the SDSS enables investors to formalise their FDI location requirements, as a ranked set of location variables, including factors such as accessibility, access to labour, and co-location with industry clusters.

Although the system is applied to the case study of FDI investment decision-making into London, the benefits can be applied to different cities or regions. Apart from the benefits for investors looking to make improved location decisions, the system enables previously tacit/informal knowledge of investor location preferences to be recorded, analysed and transformed into formal intelligence. Put in productive use, for example in a FDI promotion agency, the system can record statistically significant patterns of location variable choices, preferences and trade-offs according to investor characteristics such as industry sector, size, provenance or function. Locations can then be benchmarked against requirements by investors, identifying strengths and weaknesses of a city or regions diverse neighbourhoods.

This chapter also provides the evidence for the fulfilment of the third research goal of this thesis, namely the demonstration of the potential of the proposed SDSS through an integrated prototype system, implementing a rich and dynamic user interface allowing the support of investors business site selection and exploration of London's diverse business neighbourhoods.

The work presented here also contributes to a better understanding of the issues surrounding the integration of previously disparate tools, datasets and methods for spatial decision-making. The research methodology developed in this thesis makes a significant contribution towards modelling cognitive spatial decision preferences and trade-offs, enabling the delivery of an efficient, relevant and flexible environment for decision support.

9 Conclusion

9.1 Reflecting on the research aims and objectives

This chapter marks the conclusion of this thesis describing the efforts to develop a robust, spatially enabled methodology for the quantification and qualification of intra-city business location decision-making. The need for improved decision support in business location decision making can be traced to the hitherto lack of both relevant spatial data frameworks able to characterise and distinguish intra-city business destinations, and the lack of relevant decision making models and methods to support and improve location choice. The applied research nature of this thesis means that inward investment into London is used to guide and limit the scope of the development of a Spatial Decision Support System (SDSS) prototype, constituting the main outcome of this thesis. The development of an integrated approach to disparate datasets, methods, and tools in a prototype SDSS achieves the goal of a novel description of London's diverse business neighbourhoods, applied to the qualification of and support of investors' intra-urban business location decision-making process. The choice of a SDSS as the fundamental design paradigm also informs the research methodology and structure of the system. The SDSS, and thus also the thesis, is subdivided into four constituent parts: (1) the development of a spatial database, (2) a decision making model base, (3) a computation base generating location recommendations, and (4) a user base or interface allowing the efficient communication between system and user.

The understanding of London's polycentric business neighbourhoods and formulation of the spatial database component of the SDSS is grounded in a review of the historical, economic, and spatial processes involved in the concentration of economic activities and the role of cities. The literature review highlights the complex and multi-level spatial nature of location factors influencing firms' location decisions: accessibility to natural resources, infrastructures, and markets; the importance of co-location with competitors, suppliers, and partners; and the quality of the local workforce. This multi-disciplinary approach for a contextual understanding of the ideas, models, and processes also reveals a scarcity of systematic research into business location decision making at the intra-urban scale, highlighting the gap in knowledge addressed by this thesis. To develop a more complete understanding of location variables at the neighbourhood scale, supplemental evidence is gathered from recent competitiveness indexes and investor surveys, as well as primary and secondary empirical evidence drawn from inward investment professionals.

In summary, the research objectives can be subdivided in the following essential tasks:

1. Understand London's diverse and polycentric business environments:
    a. Identify relevant business location decision-making factors according to the literature review, competitiveness frameworks, investor surveys and primary research,
    b. Discover a coherent, consistent and relevant geographical framework modelling London's business neighbourhoods, by which to integrate disparate spatial datasets representing identified business location variables,
    c. Implement a geo-business classification of London neighbourhoods describing and distinguishing areas based on multifaceted business environment characterisations.
2. Formalise business location decision-making, qualifying and quantifying location preferences according to investor needs:
    a. Evaluate and implement an appropriate decision-making methodology to capture and analyse firms business location decision-making preferences,
    b. Develop a computational model integrating location preferences with the geo-business classification of London neighbourhoods, ranking and generating location recommendations.
3. Support business site decision-making through an integrated prototype system:
    a. Implement a dynamic and rich user interface for the system, guiding and supporting the user through the location decision-making process according to the model developed, allowing the geo-visualisation and exploration of location recommendations,
    b. Evaluate the geo-business classification and decision support methodology through a user evaluation of the prototype's relevance and consistency of recommendations.

Based on these requirements, a relevant and concise location variables database (research objective 1a) was developed, able to characterise urban areas according to industry sector clusters, the local workforce, the urban environment quality, and local property offer, as well as indicative generic public transport accessibility. This thesis also identified the inadequacies of existing administrative or statistical geographical boundaries to model London's diverse and polycentric business neighbourhoods, instead adopting the Town Centre boundaries dataset as a more suitable set of boundaries defining a set of 208 coherent, quantifiable, and representative neighbourhoods (research objective 1b) making up the Greater London conurbation. Aggregating location variables to the Town Centres geographical framework, nine geo-business dimensions are identified through a Principal Components Analysis, enabling the exploration of neighbourhoods of London exhibiting similar behaviours and characteristics (research objective 1c) according to a new geo-business classification method. This classification differs from geodemographic classifications, which attribute an exclusive label and characterisation to a given area. Instead, the geo-business classification of London neighbourhoods enables the development of multidimensional profiles for a given neighbourhood, able to capture and describe multiple facets of a given area. The geo-business classification offers a more nuanced and rich description of business neighbourhoods, not only offering the opportunity for better location decisions, but also enabling much more detailed analysis of neighbourhood competitiveness, including sophisticated and detailed demand-supply analysis's of investor location requirements (demand) and neighbourhood characteristics (supply).

This thesis also formalises and develops a business location decision-making model base, the second crucial component of the proposed SDSS. The ability to support non-expert users in exploring, expressing, and prioritising rational arguments and location preferences, as well as ambiguous emotions and feelings about location characteristics are criteria against which several candidate Multi-Criteria Decision Making methodologies were evaluated. Analytical Hierarchy Process (AHP) was chosen as the most suitable methodology in the context of business location decision making with the potential for integration with the geo-business classification (research objective 2a). AHP offers the efficient generation of absolute weights from a questionnaire of pair-wise comparisons, integrated in a flexible hierarchical decision model, structuring and managing the complexity of the decision making process. The novel application to the geo-business classification to support business location decision making was tested through an Excel spreadsheet mock-up, resolving computation issues such as the standardisation and weighting of and combination of diverse location characteristics, enabling the development of an efficient and relevant computation base (research objective 2b) for the generation of location recommendations.

The integration of both a relevant spatial database component offering a novel characterisation of London's business neighbourhoods and a flexible decision making methodology is the culmination of this thesis, exploring the potential of data and methods to improve business location decision making. The integration of these components into a functional SDSS then also serves to fulfil the research goal of a robust spatial methodology for the quantification and qualification of intra-city business location decision making. The case study of FDI investment into London guides the implementation of the prototype SDSS (research objective 3), focusing on inward investment promotion in London and its investors, which represent the prototype user base. An efficient computational environment, integrating a decision-making model and geo-business classification using a modern server/client infrastructure allows the efficient interaction between users and the system (research objective 3a). The prototype enables the capture and processing of users preferences and generation of solutions guiding users through the decision making process and visualising the complex business landscape of London.

Through a scenario-based user evaluation of the system, the consistency of outcomes between expert and non-expert FDI users was evaluated. In the context of the evaluation user groups of FDI expert and non-expert participants, the scenario outcomes were found to be consistent between groups and users. Tentative feedback on the relevance of the location recommendations was also discussed with both user groups, and the prototype system's recommendations were largely acknowledged as relevant by the FDI experts. In conclusion, the prototype SDSS implementation clearly demonstrates the contribution of this thesis towards modelling cognitive spatial decision preferences and trade-offs for supporting and improving business location decision-making, fulfilling research objective 3b.

9.2 Achievements and limitations of research

The work developed and summarised in this thesis has contributed to the fulfilment of the key research objectives set out in the previous section. Overall, the main contribution to knowledge lies in the innovative integration of disparate data sets, methods, and tools to arrive at a novel description of London's diverse business neighbourhoods, applied to a flexible and robust qualification and support of business location decision-making.

The geo-business classification offers advantages to business location decision-making, specifically when compared to previous qualitative attempts at the development of area profiles for London neighbourhoods. The geo-business classification offers a: coherent, quantifiable, and instantly recognisable geographical framework (the boundaries of which were previously left undefined in qualitative surveys), attaching widely accepted place names to geographic entities that match the wider populations' perceptions of London's geography; aggregates and standardises a set of previously disjointed proxy variables representing a set of location characteristic domains relevant to business location decision making; and develops a set of urban profiles based on statistical information as opposed to qualitative information, characterising, and summarising multifaceted neighbourhood environments in a rich and meaningful manner, managing, and limiting the complexity of the source data. The geo-business classification specifically enables decision makers with little knowledge of London to gain a deep understanding of London's diverse and complex economic landscape based on comprehensive information presented in an easy to understand manner.

The development of a relevant decision-making model and methodology also offers advantages over other Multi-Criteria Decision Making methodologies, which rely on users directly attributing weights to individual variables. The difficulty of such methods to objectively capture, process, and express intuitive judgements on the importance of location characteristics and possibly conflicting priorities is addressed through the implementation of the Analytical Hierarchy Process. Validated through the development of a prototype, the SDSS achieved the functional integration of the geo-business classification with the AHP, enabling the efficient and flexible guidance and support of business location decision making, as well as the possibility for investors to explore, compare, and rank potential business locations according to the characterisations defined by the geo-business classification.

Despite these obvious benefits and achievements compared with existing methodologies, tools, and processes, the outcomes of this thesis are still subject to a number of constraints and limitations, some of which arise from the finite nature of an EngD and the resources available for the development of this thesis. Although there has already been a more detailed discussion of specific aspects of the different components of the research, highlighting methodological and data considerations addressed in the respective chapters presenting the components, a more high-level discussion of overarching conceptual limitations is presented in the following section:

9.2.1 Geo-business classification

Section 6.3.1 – "Limitations of existing spatial data framework" presented a detailed discussion of the inherent limitations imposed by the constituent datasets from which the geo-business classification is built, as well as the constraints imposed by the choice of the Town Centre boundaries, specifically excluding industrial and commercial parks, for example. Although some of these gaps are alleviated through the data aggregation process overestimating the Town Centre Area, including business or industrial parks located in proximity to a given Town Centre, other commercial or industrial parks are excluded and further work is needed in extending the geographical framework. The integration of different spatial datasets, at varying spatial scales and aggregation levels, posed challenges given the need for detailed localised statistics relevant to the spatial scale of London's town centres, along with integration and standardisation issues for the development of compound indicators. The qualification of functional versus industry sectors in the context of available appropriate measures and datasets were identified as limitations of most, if not all, business datasets, which can fundamentally be traced back to the shortcomings of the Standard Industrial Classification, unfit to record firm site functions. A standard classification able to record and encode functional boundaries is yet to emerge.

In the development of the data requirements, the concept of accessibility is considered heavily dependent on individual requirements, including different modes of transport. The differentiation between attraction, i.e. co-location with potential suppliers, partners, and customers, as well as repulsion, the desire to be located away from competitors, also needs to be considered. In the scope of the development of the geo-business classification, the development of such complex and individual models of accessibility were deemed outside of the scope of the geo-business classification as a general characterisation of urban business environments, relevant to a wide range of investors. Given the difficulty in procuring relevant, complete, and detailed datasets of public transport accessibility and travel times between locations, the pragmatic decision to gather indicative public transport travel times from the TFL journey planner website sufficient to model and present the general level of accessibility for a given neighbourhood to Central London and its major transport hubs was made.

The geo-business classification contains statistical information on the local property stock, including the relative concentration of and quality of retail, office, warehousing, and factory space, based on the rateable value statistics, adequately describing and giving an overview of the composition of a given town centres built environment. Commercial property databases, although able to capture the current property market, were found to be inadequate in terms of quality and coverage to deliver a similarly complete overview of the property stock of a given Town Centre. Nevertheless, they do represent an important source of information on the live property offer in terms of which is of interest to potential investors. Given the very individualistic requirements of investors, based on type, size, price, and other characteristics, the live property offer cannot be integrated in a generalised geo-business classification. The capture of and integration into a decision model of investors' property requirements then offers a clear area for future research.

The methodological choices taken in the development of the geo-business classification and the repercussions on the classification need to be considered. Looking back at the established methodology developed for geodemographic classifications, the definition of a set of unique labels, one label attached to one area, for example, unambiguously characterises the resident population through the group profile, and is considered one of the main benefits of geodemographics. The geo-business classification stops short of such a clear segmentation of neighbourhoods into exclusive classes. Although such an approach could have been considered in the development of a geo-business classification of London, the a priori clustering of Town Centres into a set of exclusive clusters is considered too reductionist, and would not allow for the characterisation of multiple coincident and coexisting business environments. Rather, the goal of the geo-business classification is the reduction of the attribute complexity through a Principal Components Analysis, developing a multifaceted description of different types of potentially coincident urban environments and the attribution of similarity indexes for a given town centre for each urban environment profile. The ability of the prototype SDSS to capture and deduct absolute weights for each geo-business class from an investor's individual location preferences allows the generation of a suitability index. This index represents a bespoke classification of the suitability of business locations according to investors' needs, addressing criticisms of geodemographics voiced, for example, by Openshaw & Wymer (1995, p.243) that it is "doubtful whether satisfactory general purpose classifications can ever be devised" (see also Voas & Williamson (2001) for a critique of geodemographic classifications).

Although the present geo-business classification was deemed to be sufficiently developed to be used in the context of the evaluation of a prototype SDSS, there clearly is scope for the further evaluation of and the robustness of the geo-business classification. The choice of the number of components retained in the final classification is ultimately at the discretion of the researcher, based on a set of potentially conflicting rules of thumb. The ninth and final component “Ivory Towers” is retained because of a significant correlation between Life Sciences Industries and Higher Education Institutions, deemed relevant to business location decision making. Another source of subjectivity is the development, guided by the raw component scores, of component profiles containing profile title, interpretative descriptions, street views, and other supporting illustrations. Some users in the evaluation study expressed their concern over the subjective and potentially pejorative nature of some of the profile titles and descriptions. Whilst there is certainly an element of subjectivity, it would simply not be feasible for the end users to easily and quickly comprehend the original component scores and make informed decisions based on their own limited understanding of the components. The work done for the users in the reduction of complexity by the PCA, the selection of the relevant components, and the formulation of the component profile titles, descriptions, and illustrations then serves as a necessary step allowing the effective comprehension of the location variables database and enables users to develop a mental model of London’s business neighbourhood landscape.

9.2.2 Decision support methodology

The benefits and limitations of the development of the decision making model and methodology and its implementation in the context of the prototype SDSS can be attributed mainly to the limitations imposed by the choice and implementation of the Analytical Hierarchy Process. These limitations included the length of the questionnaires of pair-wise comparisons, limiting the number of variables that can be compared inside on a hierarchical level, and the choice of a standardisation methodology of the constituent variables.

An issue encountered and worthy of more consideration is the case in AHP where only two variables are evaluated against each other, for example, accessibility versus neighbourhood characteristics. In such a case, the absolute weights resulting from only one pair-wise comparison were deemed unrealistic by users. For example, AHP’s assignment of a significance level for “*strongly preferred*” results in a weight of 83%, a weight that during the user testing was deemed by users not to match their mental model of and definition of “*strongly”*. They felt that the nominal assignments (slightly, strongly, very strongly, and extremely) and the attached weights, as implied, did not correspond to the absolute weights assigned to these textual meanings. These concerns were noted during the user evaluation, and thus present one of the outcomes of the evaluation of AHP as a decision support methodology. The cognitive significance attributed by users to different levels of pair-wise comparisons, compared with the original levels defined by Saaty in his work, clearly presents the opportunity for further research. In the limited context of the evaluation of the potential of AHP to support business location decision making, these aforementioned limitations of the absolute weights were deemed acceptable and didn't hinder the development of an effective environment to capture and process users' business location preferences and trade-offs.

In the current implementation the Consistency Ratio, a measure of the internal consistency of the pair-wise comparisons, is generated but not exposed to the user of the system. During the user evaluation, it was found that users in general made consistent decisions, but clearly, there is the need to develop some sort of feedback mechanism to communicate with a user who is making inconsistent decisions. The challenge to communicate and identify the most inconsistent pair-wise comparisons then becomes a user interface challenge, given the potentially limited understanding by the end-user of the significance of consistency in the context of the Analytical Hierarchy Process.

The decision hierarchy implemented in the context of the prototype implementation was guided by the geo-business classification and accessibility measures detailed before. The decision hierarchy is appropriate for the definition and characterisation of a set of urban environments relevant to a wide range of investors with diverse needs and characteristics. This includes a general appreciation of the concentration of certain industry sectors, defined in terms of employment numbers in certain industry sectors, for a given geo-business class. The system currently does not support the much more individualistic assessment and exploration of a specific investor's competitive landscape, defined by the spatial distribution of potential competitors, clients, suppliers, or partners, and the potential desire for co-location with these actors. Understanding an investor's competitive landscape and co-location preferences involves significant challenges, such as the procurement of high quality, up to date, and complete datasets of individual company locations and characteristics, previously detailed in section 5.1.1 – "Companies". Even if such datasets were readily available and integrated into the decision making process, the efficient and user-friendly capture by the SDSS user interface of highly individual competitive landscapes would be complicated further by the necessary differentiation between companies an investor wants to locate close to (i.e. partners or suppliers), versus other companies the same investor wants to locate away from (probably competitors). Such a detailed capture of individual companies' competitive landscape and co-location preferences was ultimately out of scope of the research goal of the evaluation of a more general appreciation of London's diverse business neighbourhoods.

The development of decision models incorporating firm-specific location variables, including investors' accessibility requirements, co-location with potential clients, partners, competitors, or even the integration of the property offer in terms of costs, characteristics, and availability necessitates a much more extensive experience of and validation of investors' location decision-making processes. Given the limited evaluation period of the proposed decision model, and the prototype nature of the system, the development of a statistically robust historic model base of past location decisions by investors was outside the scope of this thesis. Such a library of past decision hierarchies and attached weights presents clear opportunities for the further characterisation of more individual decision models, and the development of a feedback loop improving system location recommendations, incorporating past experiences from previous users. A future development of a production system will need to take into account individual companies' decision-making processes, capturing, analysing, and integrating knowledge gained from past decisions.

9.2.3 User interface and geovisualisation

The evaluation of the prototype system represents the culmination of this research, evaluating the complete implementation and integration of the individual Spatial Decision Making System components, and the development of a prototype user interface enabling the efficient communication between users and system. The primary aim of this prototype system was the exploration of the potential of the chosen database and model base to aid spatial decision making in the context of business location decision making, and only limited consideration was given to the usability of the system, as well as the visualisation of the location recommendations. The prototype represents a fully functional implementation of the decision making process, enabling through an efficient server-client based computation base, the capture, management, and processing of users' preferences, as well as the visualisation of the location recommendations on a basic web-mapping interface, along with basic graphs enabling the evaluation and comparison of location options.

The user evaluation of the prototype system did not include real investors to London, but instead, a group of investment promotion professionals were included. The considerable experience of this group of users, both in supporting investors in business location decision making, as well as their extensive knowledge of London's diverse business neighbourhoods, made them highly relevant target users of the SDSS, and helped gain valuable feedback on the data, methodology, and interface. Although it is envisioned that a production version of the system will be made available directly to investors, given the limitations remaining in the prototype, it was deemed inappropriate to include potential investors in the evaluation campaign. Clearly, the design, functionality, and presentation of a production SDSS for business location decision making would differ significantly from the prototype, depending on the intended end users and their specific needs.

Considering the decision hierarchy implemented in this research, containing only two levels with nine geo-business classes and two accessibility measures, the previously discussed complexity and number of pair-wise comparisons did not hinder the effective and user-friendly capture of the investor's location preferences. Nevertheless, future, more complex decision hierarchies, specifically in light of the need to integrate firm level-specific location preferences discussed before, present significant user interface challenges in the effective presentation of and communication between the user and the decision model, while maintaining the pair-wise comparisons needed for the generation of the absolute weights.

The presentation of the results from the computation base, resulting from the generation of a ranking score, was an area highlighted as worthy of further consideration by the user evaluation. In its current state, the town centres are ranked from most suitable to least suitable, resulting in a long list of locations. Given the inherent dataset limitations listed before, as well as methodological limitations in the general context of decision making for ill-structured problems, the rational evaluation and generation of a "*best*" solution represents an implied level of precision potentially limiting the evaluation and comparison of location alternatives. The presentation of the outcomes in a less rigid ranking, for example classifying locations into "*very suitable*", "*somewhat suitable*", or "*unsuitable*" classes could help decision makers focus less on the outcome of the top recommendation from the system, engaging the user in the exploration of the wider potential solution space and consideration of more alternative suitable locations. Such an approach also fits well with the model of organisational decision making of a "Search Space" (see Figure 6) of acceptable solutions, extracted from the problem space, from which decision makers can select an acceptable solution.

9.3 Future developments

The previous review of benefits identified a number of limitations of the research linked to the specific methodological choices implemented in the context of this research; the necessary scope of the research thesis in terms of time and resources; and external constraints regarding data quality, quantity, or coverage. The limitations resulting from these constraints can be considered future areas of research and development towards the further fulfilment of the research goal of improving business location decision making.

In particular, the integration of additional data and the improvement of interfaces and methods to allow the integration of firm-specific location preferences is a promising area for further development and will be discussed in the following section. Further on from these data and methodological considerations, potentially wider applications are considered, through the development of both a geo-business classification covering a wider area apart from London, and the development of a production SDSS enabling improved location decision making. The opportunity exists for the development of a commercial product or service to be offered to a range of clients. These avenues for commercialisation will be explored through a brief commercialisation study.

9.3.1 Data and method improvements

As part of the future, further development of the geo-business classification, the review of the presently integrated spatial datasets representing proxy indicators for business location variables should be considered. Although the present spatial database represents a more than adequate model of salient geo-business features relevant to a wide set of investors, a future extended geo-business classification should take into account functional classifications of business activities, the characterisation of co-location preferences, the integration of live property offers, and more complete accessibility measures. The improvements are specifically useful in the characterisation of more complex decision making models qualifying individual firm-level location variables, as opposed to the general qualification of business environments developed in the scope of this thesis.

The classification of business activities according to functional boundaries relies on the development of more meaningful industrial classification, able to capture the complex functional subdivisions in and between companies. Such functional classification measures currently are not widely developed and present a very clear area for future research, including both the development of such a framework and the application of such novel measures of functional boundaries to government statistics, such as the Annual Business Inquiry. The ABI only measures the relative concentration of specific economic activities at the workplace or workforce level, crucially not identifying individual firms. This means that the ABI does not allow a detailed decision-making model addressing individual firms' co-location preferences, including co-location with competitors, partners, and suppliers. The development of such a model would necessitate the analysis of individual business records, from commercial company records databases, such as OneSource, Dun & BradStreet, or alternative databases. Even though the research resource constraints, as well as the quality issues encountered in the investigation of these datasets, meant that the integration of company databases was excluded, this is nevertheless an area where further research into relevant data frameworks and methods holds great potential.

Many of the same problems present with the company databases were encountered with commercial property databases, which capture the current property market, but were found to be inadequate in terms of quality and coverage to deliver a similarly complete overview of the property stock of a given Town Centre. However, they do represent an important source of information on the live property offer of interest to investors. Given the challenges posed by the individualistic requirements of investors, based on type, size, price, and other characteristics, the live property offer integration into a decision model of investor's property requirements then represents a firm-specific extension of the general property stock qualification used presently.

The assessment of accessibility is a much wider concept taking into account a client's co-location preferences in terms of accessibility to clients, competitors, and suppliers, as well as other businesses and general infrastructures an investor would want to be close to. The data and methodology implemented during this research, integrating a very limited set of key locations (Heathrow Airport and Central London), is only sufficient for the generation of a general indicator of accessibility to the main airport and central business district, demonstrating the ability of hierarchical decisions integrating disparate location variables. The much more detailed assessment of accessibility to bespoke locations identified by the investor necessitates a combination of much more comprehensive datasets and analysis using spatial analysis algorithms, such as for example location-allocation algorithms widely used in retail and service planning. One example of the potential of individual accessibility measures for improved decision support was developed by mySociety (2007) , integrating residential property price information and public transport travel times from a given place of employment to highlight areas both accessible and affordable (see Figure 56).

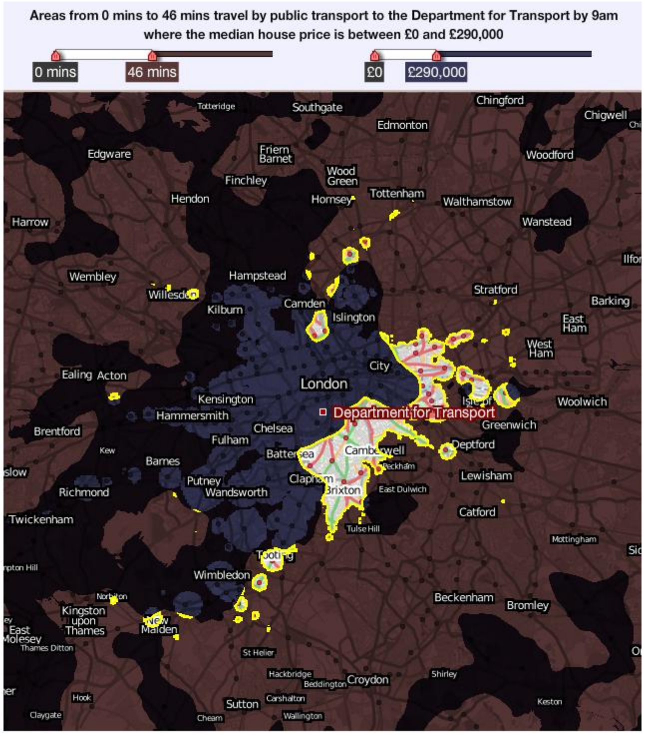


Figure 56: mySociety residential location decision support interface

The mySociety project was dependant on privileged access to comprehensive accessibility data sets by the Department for Transport and Transport for London (TFL), which remain to this date out of public access. The only public interfaces for accessibility are public journey planner services such as the TFL JourneyPlanner website. The bulk provision of the detailed public transport accessibility data supporting these services remains a challenge. However, recent developments resulting in a tentative opening of government datasets for bulk downloads, such as the GLA Data Store (GLA 2010a) offer the potential of access to relevant accessibility datasets enabling the development of much more detailed and advanced accessibility measures for business location decision making.

The development of a decision model integrating much more bespoke firm-specific location variables detailed before will result potentially in a much more complex decision making process, involving a much longer and complex questionnaire capturing individual location preferences and trade-offs. The problem of how to guide investors, simplifying the decision making process, while preserving the improved access to more firm-specific location variables represents an area for research into novel methodological approaches. One avenue is the historic analysis of past decision hierarchies from previous clients with similar characteristics. Such detailed intelligence would be useful in the refinement of the decision-making model base, leading to a library of decision hierarchies of priorities and relevant variables for different types of investors. Based on individual investor characteristics entered at the beginning of the decision making process, a relevant and proven decision hierarchy can then be chosen and presented to the investor, guiding and simplifying the decision making process, while still allowing for firm-specific location decision making.

The analysis of past decisions not only offers better location decision support to investors, but also enables the detailed analysis of neighbourhood attractiveness to investors. The analysis of a large set of past investors location preferences would allow a statistically robust model of investor demands (location characteristics preferences) to be generated, which could be compared and matched against the supply of neighbourhood characteristics. Such an analysis would enable the evaluation of and improvement of the competitiveness of regions, cities or neighbourhoods by matching demand to supply, allowing for example local authorities to better target economic development initiatives.

Finally, along with the data and methodological improvements proposed here, the development of an improved user interface, allowing the efficient communication between users and system, is envisioned. Given the need for an improved and potentially more complex decision hierarchy dependent on firm-specific location variables, the development of a more advanced user interface will incorporate means to easily manipulate and modify the relevant location variables. The capture, for example, of the detailed competitive landscape between the investor and other firms is also a user interface challenge. The potential for further research in the geo-visualisation of the location recommendations could lead to an Exploratory Spatial Data Analysis environment fit for the exploration of and comparison of London's diverse business neighbourhoods.

9.3.2 Application & commercialisation of research

Along with the improvements proposed in the previous section to include firm-specific notions of competitive landscape, accessibility, and property offer in the location decision making process, the potential for the expansion of this research into a viable commercial product application or service should be explored. These considerations were from the beginning part of this research, given that this thesis was made possible through the generous support by the Engineering Doctorate program co-financed by the Department of Computer Science and the industrial sponsor, Think London.

The prototype SDSS developed in the context of this research was applied to FDI investment promotion activities in London, and the industrial sponsor served as a great proving ground, informing the design, implementation, and evaluation of the prototype for investment location decision making. The wider application of the datasets, methods, and outputs to business location decision-making, and the potential commercial value of better location decisions for businesses is evident, but such a commercial application hasn't been investigated in a methodological manner yet. The limited scope of this thesis excludes the development of a business plan and in-depth discussion of the strengths, weaknesses, opportunities, and challenges for the commercialisation of this research. However, there is definitive value in a short discussion of some key assumptions, or hypotheses, regarding the commercialisation in terms of the product or service offer, customers, pricing, demand, and market context.

The exploration of these commercialisation and development hypotheses is formalised in the customer discovery philosophy developed in the "Four Steps to Epiphany" (Blank 2005) framework. The development of this set of assumptions regarding product, customers, channel, demand, and competitive market into a brief is an essential part of the evaluation of the commercialisation process and an early stage of the product development process in a start-up. The detailed exploration of these hypotheses can be found in Appendix 11.11 – "Commercialisation hypotheses", and are summarised in the following paragraph.

This exercise allowed the formulation of the specifics and product features necessary for the commercialisation of a relatively low-cost, web-based *business location recommendation service*, aimed at new and existing small-to medium-sized firms in a variety of industry sectors. The clients most likely to benefit from this service would be companies that do not have the resources to afford bespoke location consultancy services. The emergence of a new, low-cost location consultancy service providing a highly automated, yet individualised web service would resegment the business location consultancy market, opening up the market to new, smaller customers. Although other actors can offer similar services and threaten this new market, the competitive advantage setting this venture apart from existing competitors comes from the first mover advantage, resulting in an established customer base. Market momentum would not only be a barrier to competitors, but would also allow the development of a proprietary knowledge base on businesses location decision-making processes and variables.

9.4 Final thoughts

This thesis contributes to a better understanding of the issues surrounding spatial decision-making through the integration of previously disparate tools, datasets and methods. The creation of an end-to-end methodology that incorporated all of the elements described provided business decision makers with a robust and consistent decision framework. The development of this novel geo-business data framework and its associated spatial decision-making method and environment made a significant contribution towards extending and adapting geodemographic methodologies to represent business neighbourhood, as well as modelling cognitive spatial decision preferences and trade-offs. In particular, the work presented here contributes to a much improved and more holistic view of London's functional economic landscape, detailing different neighbourhood characteristics in a consistent geographical framework, leading to more informed location decision-making. Although focused in the case study on the use case of foreign investors to London, the methods of this thesis are flexible and in future can be applied to both different geographical areas, i.e. other cities, urban or rural areas, as well as other application domains such as for example tourism or sustainable development.

The creation of specific urban indicators for improved decision-making, applied to and integrating different data domains, can be seen as a contribution to the vision of Wilson (2008) of integrated city intelligence systems, breaking up present silo-thinking and isolated decision-making, instead driving joined-up governance and sustainable planning for cities. Government is slowly recognising the value of systematic and data driven decision-making, as evidenced by the recent open government data initiatives[60], resulting in access to ever-larger amounts of, largely spatial, information, the processing and integration of which necessitates new methods, frameworks and processes. This thesis then contributes to a rich field of future research investigating urban processes and delivering improved information and environments for decision-making, in which the existing capabilities and ideas for further work can lead the way.

[60] Data.gov.uk is a UK government project to open up and make accessible online almost all public sector datasets for free re-use, including Ordnance Survey data.

10 References

xAbrahamsson, P. et al., 2002. Agile software development methods. *Relatório Técnico, Finlândia*.

Ackroyd, P., 2001. *London: The Biography* New edition., Vintage.

Agile Alliance, 2001. Manifesto for Agile Software Development. Available at: http://agilemanifesto.org/ [Accessed December 4, 2009].

Anas, A., Arnott, R. & Small, K.A., 1998. Urban Spatial Structure. *Journal of Economic Literature*, 36(3), pp.1426-1464.

Anholt, S., 2006. The Anholt-GMI City Brands Index : How The World Views Its Cities. *Place Branding*, Vol 2(1), pp.18-31.

Anthony, R.N., 1965. *Planning and Control Systems: A framework for Analysis*, Harvard University Graduate School of Business Administration.

Arrow, K.J., 1962. The economic implications of learning by doing. *The review of economic studies*, pp.155–173.

Ascough, J.C. et al., 2002. Multicriteria Spatial Decision Support Systems: Overview, Applications, and Future Research Directions. In *Integrated Assessment and Decision Support, Proceedings of the First Biennial Meeting of the International Environmental Modelling and Software Society*. pp. 175–180.

Ashby, D.I. & Longley, P.A., 2005. Geocomputation, Geodemographics and Resource Allocation for Local Policing. *Transactions in GIS*, 9(1), pp.53-72.

Barnard, C.I. & Andrews, K.R., 1968. *The functions of the executive*, Harvard Univ Pr.

Beaverstock, J.V., Smith, R.G. & Taylor, P.J., 2000. World-City Network: A New Metageography? *Annals of the Association of American Geographers*, 90(1), pp.123-134.

Behrens, K. & Robert-Nicoud, F., 2009. Krugman's Papers in Regional Science: The 100 dollar bill on the sidewalk is gone and the 2008 Nobel Prize well-deserved. *Papers in Regional Science*, 88(2), pp.467-489.

Bekele, G.W. & Jackson, R., 2006. Theoretical perspectives on industry clusters. *Research Paper*, 5.

Bennett, R.J., Graham, D.J. & Bratton, W., 1999. The Location and Concentration of Businesses in Britain: Business Clusters, Business Services, Market Coverage and Local Economic Development. *Transactions of the Institute of British Geographers*, 24(4), pp.393-420.

Berkoz, L. & Eyuboglu, E., 2007. Intrametropolitan Location of Producer-service FDI - in Istanbul. *European Planning Studies*, 15(3), p.357.

Berkoz, L. & Turk, S.S.S.S., 2008. Determination of location-specific factors at the intra-metropolitan level: Istanbul case. *Tijdschrift voor economische en sociale geografie*, 99(1), pp.94-114.

Blank, S.G., 2005. *The Four Steps to the Epiphany*, Cafepress.com.

Borensztein, E., De Gregorio, J. & Lee, J., 1998. How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1), pp.115-135.

Bowman, D.A., Gabbard, J.L. & Hix, D., 2002. A survey of usability evaluation in virtual environments: Classification and comparison of methods. *Presence: Teleoperators & Virtual Environments*, 11(4), pp.404–424.

Breschi, S. & Malerba, F., 2005. Clusters, networks, and innovation: Research results and new directions. *Clusters, Networks, and Innovation*, pp.1–26.

Button, K. & Stough, R., 1998. *The Benefits of Being a Hub Airport City: Convenient Travel and High-Tech Job Growth*, Fairfax, VA: The Institute of Public Policy, George Mason University.

Camagni, R., 2002. On the Concept of Territorial Competitiveness: Sound or Misleading? *Urban Studies*, 39(13), p.2395.

Carver, S.J., 1991. Integrating multi-criteria evaluation with geographical information systems. *International Journal of Geographical Information Science*, 5(3), pp.321-339.

Case, M.P., 2001. *Decision Support Capabilities for Future Technology Requirements*, U.S. Army Corps of Engineers.

Castells, M., 1996. *Rise of the Network Society*, Blackwell Publishers, Inc. Available at: http://portal.acm.org/citation.cfm?id=524435 [Accessed February 7, 2010].

Caves, R.E., 1996. *Multinational enterprise and economic analysis*, Cambridge Univ Pr.

Charlton, M., Openshaw, S. & Wymer, C., 1985. Some new classifications of census enumeration districts in Britain: a poor man's ACORN. *Journal of Economic and Social Measurement*, 13(1), pp.69–96.

Cheng, L.K. & Kwan, Y.K., 2000. What are the determinants of the location of foreign direct investment? The Chinese experience. *Journal of International Economics*, 51(2), pp.379-400.

Chesbrough, H., 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press.

Christaller, W., 1933. Central places in southern Germany (translated by CW Baskin, 1966). *Englewood Cliffs, NJ*.

Cieslik, A., 2005. Regional characteristics and the location of foreign firms within Poland. *Applied Economics*, 37(8), pp.863-874.

Cohen, 2000. *Business Location Decision-making and the Cities: Bringing Companies Back*, Brookings Institution Center on Urban and Metropolitan Policy. Available at: http://www.brookings.edu/es/urban/COHEN.PDF.

Cooke, P. & Leydesdorff, L., 2006. Regional Development in the Knowledge-Based Economy: The Construction of Advantage. *The Journal of Technology Transfer*, 31(1), pp.5-15.

Coughlin, C.C., Terza, J.V. & Arromdee, V., 1991. State Characteristics and the Location of Foreign Direct Investment within the United States. *The Review of Economics and Statistics*, 73(4), pp.675-683.

Crozet, M., Mayer, T. & Mucchielli, J., 2004. How do firms agglomerate? A study of FDI in France. *Regional Science and Urban Economics*, 34(1), pp.27-54.

Cushman & Wakefield, 2009. European Cities Monitor, Business Locations In Europe. Available at: http://www.europeancitiesmonitor.eu/ [Accessed February 22, 2010].

De Propris, L. et al., 2009. The Geography of Creativity. *NESTA: London*.

De Propris, L., Driffield, N. & Menghinello, S., 2005. Local industrial systems and the location of FDI in Italy. *International Journal of the Economics of Business*, 12(1), pp.105-121.

Densham, P.J., 1991. Spatial decision support systems. In *Geographical Information Systems: Principles and Applications*. London: Longman, pp. 403-412.

Department of Communities and Local Government, 2009. Indices of Deprivation 2007. *Indices of Deprivation 2007*. Available at: http://www.communities.gov.uk/communities/neighbourhoodrenewal/deprivation/deprivation07/ [Accessed July 21, 2009].

Derbyshire, M.E., 1983. The Application of Statistical Methods in Personal Social Services--A Review. *Journal of the Royal Statistical Society. Series A (General)*, 146(2), pp.115-149.

Dicken, P., 2003. *Global shift: Reshaping the global economic map in the 21st century*, Sage Publications Ltd.

Donegan, H.A., Dodd, F.J. & McMaster, T.B.M., 1992. A new approach to AHP decision-making. *The Statistician*, 41, pp.295-302.

Dumas, J.S. & Redish, J., 1999. *A practical guide to usability testing*, Intellect Ltd.

Dunning, J.H., 1994. *Reevaluating the Benefits of Foreign Direct Investment*, University of Reading, Department of Economics.

Dunning, J.H. & Lundan, S.M., 2008. *Multinational enterprises and the global economy*, Edward Elgar Publishing.

Dunteman, G.H., 1989. *Principal Components Analysis*, SAGE.

Edwards, W. & Barron, F.H., 1994. SMARTS and SMARTER: Improved simple methods for multiattribute utility measurement. *Organizational Behavior and Human Decision Processes*, 60(3), pp.306–325.

Ellison, G. & Glaeser, E.L., 1997. Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach. *Journal of Political Economy*, 105(5), pp.889-927.

Experian, 2009. MOSAIC UK 2009. Available at: http://www.business-strategies.co.uk/ [Accessed July 20, 2009].

Florida, R., 2003. Cities and the Creative Class. *City and Community*, 2(1), pp.3-19.

Florida, R., 2005. *The Flight of the Creative Class: The New Global Competition for Talent*, Collins.

Florida, R., 2003. *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life*, Basic Books.

Flynn, M., Flynn, P. & Mellor, N., 1972. Social malaise research: a study in Liverpool. *Social Trends*, 3, pp.42–52.

Forman, E.H., 1993. Facts and fictions about the analytic hierarchy process. *Mathematical and Computer Modelling*, 17(4-5), pp.19-26.

Forman, E.H. & Gass, S.I., 2001. The Analytic Hierarchy Process--An Exposition. *OPERATIONS RESEARCH*, 49(4), pp.469-486.

Friedman, T.L., 2005. *The World is Flat*, Farrar, Straus and Giroux.

Friedmann, J., 1986. The world city hypothesis. *Development and change*, 17(1), pp.69–83.

Friedmann, J. & Wolff, G., 1982. World city formation: an agenda for research and action. *International Journal of Urban and Regional Research*, 6(3), pp.309-344.

Fülöp, J., 2004. Introduction to decision making methods. In *Paper developed for the BDEI-3 Workshop, The Evergreen State College*. BDEI-3 Workshop.

Ghosh, D., 2008. A Loose Coupling Technique for Integrating GIS and Multi-Criteria Decision Making. *Transactions in GIS*, 12(3), pp.365-375.

Girma, S., Greenaway, D. & Wakelin, K., 2001. Who Benefits from Foreign Direct Investment in the UK? *Scottish Journal of Political Economy*, 48(2), pp.119-133.

GLA, 2010a. London DataStore. *Greater London Authority - London DataStore*. Available at: http://data.london.gov.uk/ [Accessed May 10, 2010].

GLA, 2010b. *London's creative workforce (2009 update)*, London: Greater London Authority. Available at: http://www.london.gov.uk/who-runs-london/mayor/publications/business-and-economy/londons-creative-workforce-2010-update [Accessed February 19, 2010].

Glaeser, E.L. et al., 1992. Growth in Cities. *Journal of Political Economy*, 100(6), p.1126.

Godin, B., 2006. The Knowledge-Based Economy: Conceptual Framework or Buzzword? *The Journal of Technology Transfer*, 31(1), pp.17-30.

Gordon, I.R. & McCann, P., 2000. Industrial Clusters: Complexes, Agglomeration and/or Social Networks? *Urban Stud*, 37(3), pp.513-532.

Gorry, G. & Scott-Morton, M., 1971. A framework for Managment Information Systems. *Sloan Management Review*, Volume 13(Issue 1), pp.56-79.

Government Office for London, 2008. *The London Economy: Responding to changing economic circumstances*, London: Government Office for London. Available at: http://www.gos.gov.uk/497417/docs/182612/The_London_Economy_New.pdf [Accessed March 29, 2009].

Graham, E. & Krugman, P., 1995. *Foreign Direct Investment in the United States*, Peterson Institute.

Green, P.E., Krieger, A.M. & Wind, Y.(., 2001. Thirty Years of Conjoint Analysis: Reflections and Prospects. *Interfaces*, 31(3), pp.S56-S73.

Green, P.E. & Srinivasan, V., 1978. Conjoint Analysis in Consumer Research: Issues and Outlook. *Journal of Consumer Research*, 5(2), p.103.

Guimarães, P., Figueiredo, O. & Woodward, D., 2000. Agglomeration and the Location of Foreign Direct Investment in Portugal. *Journal of Urban Economics*, 47(1), pp.115-135.

Haggett, P., 1967. Review: Three Pioneers in Locational Theory: Review. *The Geographical Journal*, 133(3), pp.357-359.

Hall, P., 1999. *Cities in civilization*, Phoenix Giant.

Hall, P., 2003. The End of the City?"The Report of My Death was an Exaggeration". *City*, 7(2), pp.141–152.

Hall, P., 1966. *The world cities*, London, Weidenfeld.

Hall, P. & Pain, K., 2006. The polycentric metropolis: learning from mega-city regions in Europe.

Harris, R., Webber, R. & Sleight, P., 2005. *Geodemographics, GIS and neighbourhood targeting*, John Wiley & Sons Inc.

Harris, R.J. & Longley, P.A., 2002. Creating small area measures of urban deprivation. *Environment and Planning A*, 34(6), pp.1073 – 1093.

Harrison, E.F., 1999. *The managerial decision-making process*, Houghton Mifflin.

Head, K. & Ries, J., 1996. Inter-City Competition for Foreign Investment: Static and Dynamic Effects of China's Incentive Areas. *Journal of Urban Economics*, 40(1), pp.38-60.

Hebbert, M., 1998. *London: More by Fortune than Design*, London: John Wiley.

Herbert, D.T., 1968. Principal components analysis and british studies of urban-social structure. *The Professional Geographer*, 20(4), p.280.

Hill, S. & Munday, M., 1992. The UK - Regional Distribution of Foreign Direct Investment: Analysis and Determinants. *Regional Studies*, 26(6), p.535.

Hirschmann, A.O., 1958. *The strategy of economic development*, USA: Yale University Press.

Hoover, E.M., 1948. *The Location of Economic Activity*, McGraw-Hill.

Hotz-Hart, B., 2000. Innovation networks, regions, and globalization. *The Oxford handbook of economic geography*, pp.432–450.

Hymer, S.H., 1976. *The international operations of national firms*, MIT Press

Cambridge, Mass.

Ihlanfeldt, K.R. & Raper, M.D., 1990. The Intrametropolitan Location of New Office Firms. *Land Economics*, 66(2), pp.182-198.

Jackson, D.A., 1993. Stopping Rules in Principal Components Analysis: A Comparison of Heuristical and Statistical Approaches. *Ecology*, 74(8), pp.2204-2214.

Jacobs, J., 1970. *The economy of cities*, Vintage Books.

Jankowski, P., 1995. Integrating geographical information systems and multiple criteria decision-making methods. *International Journal of Geographical Information Science*, 9(3), pp.251-273.

Johnston, R.J., 2000. *The dictionary of human geography*, Blackwell Publishers.

Jones, C.E., 2008. *Modelling health related behaviours using geodemographics: applications in social marketing and preventative health*. PhD Thesis. University College London.

Jones, J. & Wren, C., 2008. *FDI Location Across British Regions and Inward Investment Policy*, London: LSE Spatial Economics Research Centre.

Kaiser, H.F., 1960. The Application of Electronic Computers to Factor Analysis. *Educational and Psychological Measurement*, 20(1), pp.141-151.

Kavaratzis, M. & Ashworth, G.J., 2005. City branding: An effective assertion of identity or a transitor marketing trick? *Tijdschrift voor Economische en Sociale Geografie*, 96(5), pp.506-514.

Keeble, D. & Nachum, L., 2002. Why Do Business Service Firms Cluster? Small Consultancies, Clustering and Decentralization in London and Southern England. *Transactions of the Institute of British Geographers*, 27(1), pp.67-90.

Keen, P.G. & Morton, M.S., 1978. *Decision support systems: an organizational perspective*, Addison Wesley Publishing Company.

Keeney, R.L. & Raiffa, H., 1976. *Decisions with Multiple Objectives: Preferences and Tradeoffs*, New-York: Wiley.

Kitson, M., 2005. Entreprising and Creative Places. Available at: http://www.cambridge-mit.org/cgi-bin/default.pl?SID=3&SSID=99.

Kitson, M., Martin, R. & Tyler, P., 2004. Regional Competitiveness: An Elusive yet Key Concept? *Regional Studies: The Journal of the Regional Studies Association*, 38(9), pp.991-999.

Kloosterman, R.C. & Musterd, S., 2001. The polycentric urban region: towards a research agenda. *Urban Studies*, 38(4), pp.623–633.

KPMG, 2008. *Competitive Alternatives 2008 - KPMG's Guide to International Business Location*, KPMG. Available at: http://www.competitivealternatives.com/download/archive.aspx [Accessed September 8, 2010].

Krugman, P., 1991. Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), p.483.

Krugman, P., 1998. What's new about the new economic geography? *Oxford Review of Economic Policy*, 14(2), pp.7-17.

Krugman, P., 2000. Where in the world is the ‘new economic geography’. In *The Oxford Handbook of Economic Geography*. pp. 49-60.

Laulajainen, R. & Stafford, H.A., 1995. *Corporate geography: business location principles and cases*, Kluwer Academic Pub.

LDA, 2009. Snapshot of BIDs across London, June 2009 - London BIDs. *London Business Improvement Districts*. Available at: http://www.londonbids.co.uk/archive/snapshot-of-bids-across-london-june-2009.html [Accessed June 3, 2010].

LDA, 2005. *Sustaining Success - Economic Development Strategy*, London: London Development Agency.

LDA, 2010. *The Mayor's Economic Development Strategy*, London Development Agency. Available at: http://lda-consult.limehouse.co.uk/portal/eds/eds?pointId=552#target-d3605655e1297 [Accessed February 22, 2010].

LDA, 2003. *Understanding London's Sectors*, London: London Development Agency.

Leigh, 1970. The use of location quotients in urban economic base studies. *Land economics*, 46(2), p.202.

Little, J.D., 1970. Models and Managers: The Concept of a Decision Calculus. *Managment Science*, 16(8), pp.466-485.

Lloyd, D., 2004. *Uncertainty in Town Centre Definition*. PhD Thesis. University College London.

London School of Economics, 2009. The survey into life and labour in London (1886-1903) (Charles Booth Online Archive). Available at: http://booth.lse.ac.uk/static/b/index.html [Accessed June 10, 2009].

Longley, P. & Clarke, G., 1995. *GIS for business and service planning*, John Wiley and

Sons.

Louviere, J.J., Eagle, C.E. & Cohen, S.H., 2005. *Conjoint Analysis: Methods, Myths and Much More*, Sydney: CEnSoc, University of Technology.

Luce, R.D. & Tukey, J.W., 1964. Simultaneous conjoint measurement: A new type of fundamental measurement. *Journal of mathematical psychology*, 1(1), pp.1–27.

MacKinnon, D. & Cumbers, A., 2007. *An Introduction to Economic Geography*, Pearson Education.

Malczewski, J., 1999. *GIS and Multicriteria Decision Analysis*, New-York: John Wiley.

Marakas, G.M., 1999. *Decision Support Systems in the 21th Century*, New Jersey: Prentice-Hall.

Marcon, E. & Puech, F., 2003. Evaluating the geographic concentration of industries using distance-based methods. *J Econ Geogr*, 3(4), pp.409-428.

Marcon, E. & Puech, F., 2006. Generalizing Ripley's K function to inhomogeneous populations.

Marcon, E. & Puech, F., 2007. Measures of the geographic concentration of industries: improving distance-based methods. *Cahiers de la MSE*, 18, p.22.

Marshall, A., 1890. *Principles of Economics*, Macmillan and Co.

Martin, R. & Sunley, P., 2003. Deconstructing clusters: chaotic concept or policy panacea? *J Econ Geogr*, 3(1), pp.5-35.

Moser, C.A. & Scott, W., 1961. *British towns: a statistical study of their social and economic differences*, Oliver and Boyd.

Mullen, J. & Williams, M., 2005. Foreign Direct Investment and Regional Economic Performance. *Kyklos*, 58(2), pp.265-282.

Myrdal, G., 1957. *Economic Theory and Underdeveloped Regions*, London: Duckworth.

mySociety, 2007. Commuting Time Maps. *mySociety Website*. Available at: http://www.mysociety.org/2007/more-travel-maps/ [Accessed May 10, 2010].

Nachum, L. & Keeble, D., 1999. *A Marshallian approach to the eclectic paradigm of foreign investment: The clustering of film TNCs in Central London*, ESRC Centre for Business Research, University of Cambridge.

Nachum, L. & Keeble, D., 2000. Foreign and indigenous firms in the media cluster of central London. *ESRC Centre for Business Research Working Papers*, (154).

Nachum, L. & Keeble, D., 2003. MNE linkages and localised clusters: foreign and indigenous firms in the media cluster of Central London. *Journal of International Management*, 9(2), pp.171-192.

Nielsen, J., 2000. Usability Testing with 5 Users (Jakob Nielsen's Alertbox). Available at: http://www.useit.com/alertbox/20000319.html [Accessed December 15, 2009].

Norman, P., 1969. Third survey of London life and labor: A new typology of London districts'. *Quantitative Ecological Analysis in the Social Sciences*, pp.371–96.

ODPM, 2004. *Producing Boundaries and Statistics for Town Centres*, London: Office of the Deputy Prime Minister.

OECD, 2005. *OECD Handbook on Economic Globalisation Indicators*, OECD, Paris.

Office for National Statistics, S.F., 2008. Names and codes for Super Output Area Geography. Available at: http://www.ons.gov.uk/about-statistics/geography/products/geog-products-area/names-codes/soa/index.html [Accessed July 19, 2010].

Office of National Statistics, 2008. Annual Business Inquiry - Background information. *Annual Business Inquiry - Background information*. Available at: http://www.statistics.gov.uk/abi/background_info.asp [Accessed July 21, 2009].

Office of National Statistics, 2001. National Statistics 2001 Area Classification. *Office of National Statistics Website*. Available at: http://www.statistics.gov.uk/about/methodology_by_theme/area_classification/default.asp [Accessed July 20, 2009].

Office of National Statistics, 2008. The IDBR Inter-Departmental Business Register; a key survey source. *The IDBR Inter-Departmental Business Register; a key survey source*. Available at: http://www.statistics.gov.uk/CCI/nugget.asp?ID=195 [Accessed July 21, 2009].

Openshaw, S. & Wymer, C., 1995. Classifying and regionalizing census data. *Census users' handbook*, pp.239–270.

Oum, T.H. & Park, J., 2004. Multinational firms' location preference for regional distribution centers: focus on the Northeast Asian region. *Transportation Research Part E: Logistics and Transportation Review*, 40(2), pp.101-121.

van der Panne, G., 2004. Agglomeration externalities: Marshall versus Jacobs. *Journal of Evolutionary Economics*, 14(5), pp.593-604.

Park, R.E. et al., 1925. *The city*, The University of Chicago Press.

Parr, J.B., 1999. Growth-pole Strategies in Regional Economic Planning: A Retrospective View: Part 1. Origins and Advocacy. *Urban Studies*, 36(7), p.1195.

Pearce, G. & Ayres, S., 2009. Governance in the English Regions: The Role of the Regional Development Agencies. *Urban Studies*, 46(3), pp.537-557.

Pearson, K., 1901. On lines and planes of closest fit to systems of points in space. *Philosophical magazine*, 2(6), pp.559–572.

Porter, M., 2000. Location, Competition, and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14(1), p.15.

Porter, M., 2003. The Economic Performance of Regions. *Regional Studies*, (6&7), pp.549-578.

Porter, M. & Ketels, C., 2003. UK Competitiveness: moving to the next stage. *DTI ECONOMICS PAPER*, (NO. 3), p.60.

Power, D., 2007. A Brief History of Decision Support Systems. Available at: http://www.dssresources.com/history/dsshistory.html.

Pratt, A.C., 2009. Urban Regeneration: From the Arts `Feel Good' Factor to the Cultural Economy: A Case Study of Hoxton, London. *Urban Stud*, 46(5-6), pp.1041-1061.

PriceWaterhouseCoopers, 2008. Global city GDP rankings 2008-2025. Available at: http://www.ukmediacentre.pwc.com/Content/Detail.asp?ReleaseID=3421&NewsAreaID=2 [Accessed January 13, 2010].

Procher, V., 2009. FDI location choices: Evidence from French first-time movers. *AStA Wirtschafts- und Sozialstatistisches Archiv*, 3(3), pp.209-220.

Regional Development Agencies, 2009. England's RDAs. *England RDAs - Who we are*. Available at: http://www.englandsrdas.com/who_we_are/ [Accessed February 13, 2010].

Reyck, B.D., Degraeve, Z. & Grushka-Cockayne, Y., 2005. *System Performance Trade-Offs*, London Business School.

Robinson, G.M., 1998. *Methods and techniques in human geography*, London: J. Wiley.

Romer, P.M., 1986. Increasing returns and long-run growth. *The Journal of Political Economy*, 94(5).

Roth, C. et al., 2010. Commuting in a polycentric city. *1001.4915*. Available at: http://arxiv.org/abs/1001.4915 [Accessed February 10, 2010].

Ruggiero, A., 2005. Paul Krugman and the New Economic Geography-assesment in the light of the dynamics of a “real world” local system of firms. In *Proceedings of the 45th Congress of the European Regional Science Association*. 45th Congress of the European Regional Science Association. Amsterdam.

Saaty, T.L., 1977. A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology*, 15(3), pp.234-281.

Saaty, T.L., 1990. How to make a Decision: The Analytical Hierarchy Process. *European Journal of Operational Research*.

Saaty, T.L., 2008. Relative measurement and its generalization in decision making. *Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A: Matemáticas (RACSAM)*, 102(2), p.251.

Sassen, S., 2002. Cities in a world economy. *Readings in urban theory*, p.32.

Sassen, S., 2001. *The Global City: New York, London, Tokyo*, Princeton University Press.

Saxenian, A., 1991. The origins and dynamics of production networks in Silicon Valley. *Research Policy*, 20(5), pp.423-437.

Schumpeter, J.A., 1934. *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle* 1983rd ed., Transaction Publishers.

Scott, A.J., 2001. Globalization and the Rise of City-regions. *European Planning Studies*, 9(7), pp.813-826.

Shevky, E. & Bell, W., 1961. Social area analysis. *Studies in human ecology*, pp.69–84.

Shim, J.P. et al., 2002. Past, present, and future of decision support technology*. *Decision support systems*, 33(2), pp.111–126.

Simmie, J., 2001. *Innovative Cities* 1st ed., Routledge.

Simon, H.A., 1976. *Administrative behavior*, Free Press.

Simon, H.A., 1987. Making Management Decisions: The Role of Intuition and Emotion. *The Academy of Management Executive (1987)*, 1(1), pp.57-64.

Simon, H.A., 1960. *The New Science of Managment Decision*, New-York: Harper & Row.

Singleton, A., 2004. A State of the Art Review of Geodemographics and their Applicability to the Higher Education Market. *Centre for Advanced Spatial Analysis*, (Paper 74), p.16.

Sleight, P., 1997. *Targeting Customers: how to use geodemographic and lifestyle data in your business,* NTC Publications Henley on Thames, UK.

Smith, D.F. & Florida, R., 1994. Agglomeration and Industrial Location: An Econometric Analysis of Japanese-Affiliated Manufacturing Establishments in Automotive-Related Industries. *Journal of Urban Economics*, 36(1), pp.23-41.

Sol, H.G., Takkenberg, C.A.T. & Robbé, P.F.D.V., 1987. *Expert systems and artificial intelligence in decision support systems: proceedings of the Second Mini Euroconference, Lunteren, The Netherlands, 17-20 November, 1985*, Springer.

Sprague, R., 1980. A Framework for the development of Decision Support Systems. *MIS Quarterly*, Volume 4(Number 4).

Sprague, R. & Watson, H., 1993. *Decision Support Systems: Putting theory into Practice*, New Jersey: Prentice-Hall, Inc.

Steinle, C. & Schiele, H., 2002. When do industries cluster?: A proposal on how to assess an industry's propensity to concentrate at a single region or nation. *Research Policy*, 31(6), pp.849-858.

Taylor, P.J. et al., 2009. Measuring the World City Network: New Developments and Results'. *GaWC Research Bulletin*, 300.

Think London, 2006a. *52 Billion: The value of Foreign Direct Investment to London*, Think London. Available at: http://www.thinklondon.com/dynamic/downloads/london_focus/2007/secure_D4_london_focus_52billion.pdf [Accessed January 3, 2009].

Think London, 2006b. *Area Profiles - Pilot Study,* London: Think London.

Think London, 2006c. *Think London Qualitative Investor Survey*, London: Think London.

von Thünen, J.H., 1826. *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*, Akademie Verlag.

Thurstain-Goodwin & Unwin, D., 2000. Defining and Delineating the Central Areas of Towns for Statistical Monitoring Using Continuous Surface Representations. *Transactions in GIS*, 4(4), pp.305-317.

Thurstain-Goodwin, M. et al., 2001. *Producing Boundaries and Statistics for Town Centres*, CASA, Center for Advanced Spatial Analysis, London.

Tyler, R.W., Gagné, R.M. & Scriven, M., 1967. *Perspectives of curriculum evaluation,* Rand McNally Chicago.

United Nations, 2009. *World Investment Report 2009*, United Nations Conference on Trade and Investment. Available at: http://www.unctad.org/Templates/WebFlyer.asp?intItemID=5037&lang=1 [Accessed January 3, 2009].

University of Redlands and the SDS Consortium, 2009. Spatial Decision Support Knowledge Portal. Available at: http://www.institute.redlands.edu/sds/welcome.html [Accessed July 29, 2010].

URBED, 2002. *A City of Villages: Promotion a sustainable future for London's suburbs*, London: Greater London Authority. Available at: http://www.london.gov.uk/mayor/planning/docs/tr11_villages.pdf.

Vaidya, O. & Kumar, S., 2006. Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169(1), pp.1-29.

Vargas, L., 1989. Why the Analytic Hierarchy Process Is Not Like Multiattribute Utility Theory. *Lecture Notes in Economics and Mathematical Systems*, 356, pp.53–60.

Vickers, D. & Rees, P., 2007. Creating the UK National Statistics 2001 output area classification. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 170(2), pp.379-403.

Voas, D. & Williamson, P., 2001. The Diversity of Diversity: A Critique of Geodemographic Classification. *Area*, 33(1), pp.63-76.

Weber, A., 1929. *Theory of the Location of Industries, translated by CJ Friedrich*, University of Chicago, Chicago, IL.

Weber, P., 2008. Investing in GI for a successfull London: a review of benefits. In *AGI Annual Conference Proceedings*. AGI Geocommunity. Stratford-upon-Avon: Association for Geographic Information.

Weber, P. & Chapman, D., 2009. Investing in geography: A GIS to support inward investment. *Computers, Environment and Urban Systems*, 33(1), pp.1-14.

Wheeler, D. & Mody, A., 1992. International investment location decisions : The case of U.S. firms. *Journal of International Economics*, 33(1-2), pp.57-76.

Wilson, A., 2008. Science and the city. *Environment and Planning A*, 40(12), pp.2800-2808.

Wu, F., 1999. Intrametropolitan FDI firm location in Guangzhou, China A Poisson and negative binomial analysis. *The Annals of Regional Science*, 33(4), pp.535-555.

Wu, F., 2000. Modelling Intrametropolitan Location of Foreign Investment Firms in a Chinese City. *Urban Stud*, 37(13), pp.2441-2464.

Wu, J. & Radbone, I., 2005. Global integration and the intra-urban determinants of foreign direct investment in Shanghai. *Cities*, 22(4), pp.275-286.

11 Appendices

11.1 FDI location decision making requirements

Data Requirements	**Potential Users**
Infrastructures and facilities • Data about Public and private transport facilities & services, on a local, national and international level. (e.g. Tube, Bus, Train Stations, Airports as well as the road network). • This also includes the logistics network and facilities (ports, airfreight, rail transport of goods).	**BDMs** & **Regional Reps** need to assess accessibility for goods (logistic sector clients) and persons, as well as commuting times to give their clients an understanding of the transport network. **Market Research** & **Marketing** need to deliver strategic intelligence to the **Executive Team** about London's transport network. **Internet Users** want to see the main transport links in London.
• The Power Grid, its capacity and which areas are covered for high demand customers. • High capacity communication networks (including specifics of data centres)	**BDM's** and **Regional Rep.'s** need to answer enquiries from clients that have specific energy needs, or need very good communication links.
Environmental Services & Infrastructure • Environmental Sector activities and actors. • Water supply network, treatment facilities, waste stream producers and processing facilities.	**Regional Rep's** from East London designate environmental technology as a target sector to promote as a opportunity for their clients. **Market Researchers** & **Marketing** want more information about this key sector, its development potential and key players.
Public Services • Education infrastructure and ratings, including all state and independent schools (as well as international schools), as well as universities and their departments. • University research centres and semi private and	**BDM's** & **Regional Rep's** want to show their clients the best schools London has to offer. **Market Researcher's** & **Marketing** are interested in mapping R&D activities, both public and private. Internet Users want information about schools and

private R&D centres.	universities.
Healthcare • Data about the NHS infrastructure, private healthcare facilities and supply and demand in the healthcare sector.	**BDM's** & **Market Researchers** want to improve the proposition for investment in the health care sector and attract investment in the sector.
Commercial Property • Serviced and non serviced offices: offer and demand, characteristics and costs. • Brownfield sites open for development. • Industrial & Commercial Parks, characteristics and offer. • Incubators and their offer.	**BDM's** & **Regional Rep's** want a better way to develop for their clients a set of property options to set up business or build facilities. **Market Researchers** & **Executive Team** need to improve their strategic outlook on demand and supply in the property sector. **Marketing** wants to show **Internet Users** office options and sites that are open to development.
Residential Properties • Private property information offer and characteristics.	**BDM's** & **Regional Rep's** need to find suitable accommodation options according to set criteria defined by the client.
Socio-demographic data • Demographic information of population characteristics and ethnic communities. • Social Infrastructures and Activities, e.g. parcs and nightlife, places of worship, shopping streets…	**Market Researchers** & **Marketing** want to showcase the cultural and ethnic diversity of London. **BDM's** & **Regional Rep's** want to help their clients find the right neighbourhood.
• Skill levels and salary information of different population groups.	**Market Researchers** want to develop intelligence on the knowledge base offer.

Company Data • Information about theThink London members, clients, completions of the past and present, multipliers & partners. • Business Support Networks and Business Associations that provide help to companies. • Business directories and databases which list all companies that are active in London, on a national and international level.	**BDM's** & **Regional Rep's** need to be able to visualise the business landscape and identify suitable location for their clients, close or away from their key competitors, clients & suppliers. **Market Research** & **Marketing** want to know the makeup of the business landscape in London and identify key sectors and activity clusters. **The Executive team** wants to gain a good understanding of sector clusters and map the completions of Think London. **Internet Users** will want to know the key businesses that are present in London.
Business Intelligence • Retail and tourist hubs location and characteristics • Business and economic data, employment indicators. • Public policy intelligence and development promotion areas.	**BDM** & **Regional Reps** need to gather information for their retail and hospitality sector clients. **Market Research** & **Marketing** want intelligence on the economic development and employement market, which the **Executive team** can use to make informed decisions on the direction of FDI.

11.2 M function Analysis

11.2.1 By Country of Origin

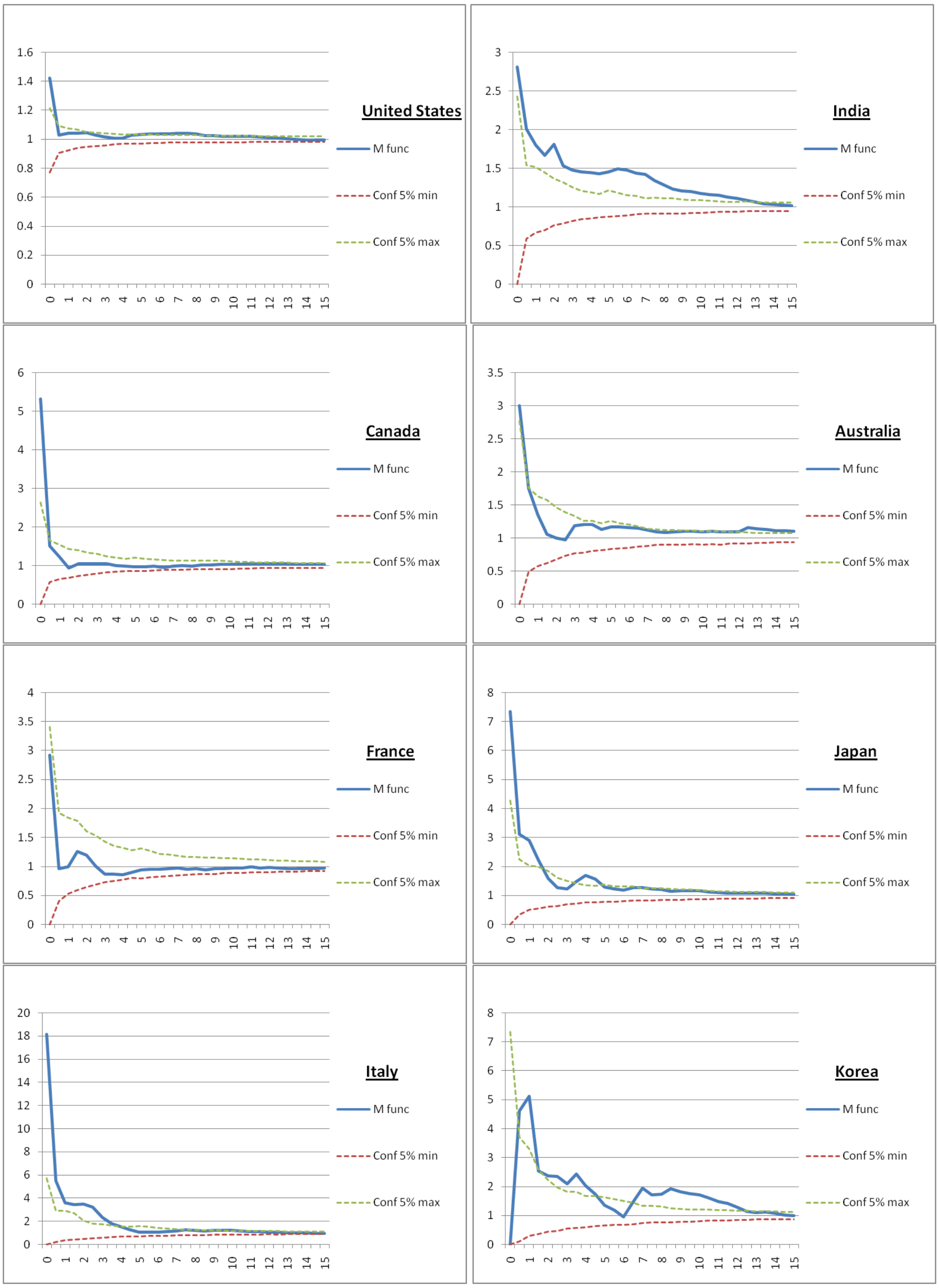
Given the large sample of origin countries, and the relative concentration of the majority of investments from a small selection of countries, we decided to only generate the M function for a reduced set of origins, where the count of investments was superior to 10. This left us with 14 countries of origin that we can compare.

Origin	Count
Ireland	11
Israel	13
Spain	13
China	14
Germany	14
Sweden	15
Korea	22
Italy	26
Japan	36
France	41
Australia	51
Canada	61
India	67
United States	259

First, we can see that for some countries, there is a marked tendency to agglomeration over short distances. For the United States for example, given the large sample size, we can still see that in the first 500 metres, there is a marked tendency to agglomeration. The curves of the M function grossly for most countries follow a similar pattern of a return to 1 as the distance increases.

There are no discernable patterns of dispersion out of the graphs, but some interesting patterns of apparent agglomeration. Indian FDI investors seem to be significantly more agglomerated over the first few kilometres than the rest of FDI investors.

Korean FDI investors M function exposes a much more complex picture, which could be explained by the smaller sample size, and anecdotal evidence from Think London project managers that Korean Companies cluster in specific areas of London.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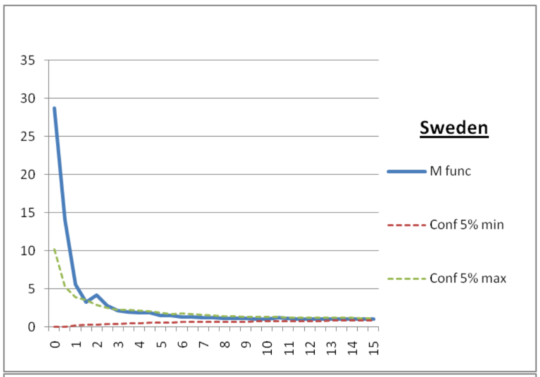

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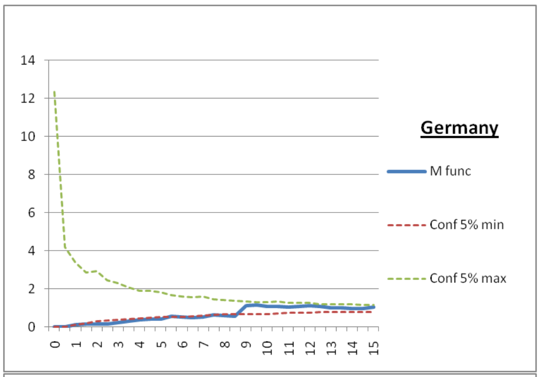

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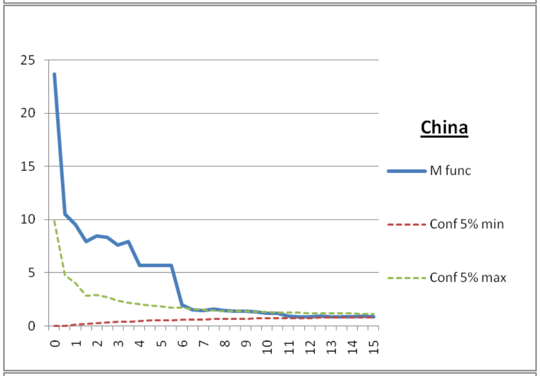

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China
M func
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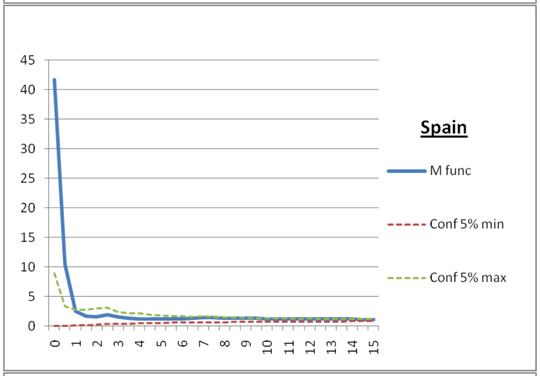

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Spain
M func
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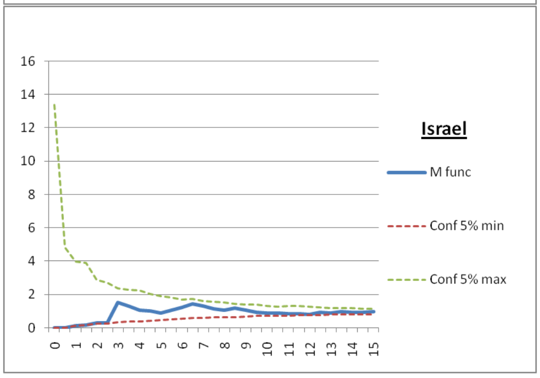

16
14
12
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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Israel
M func
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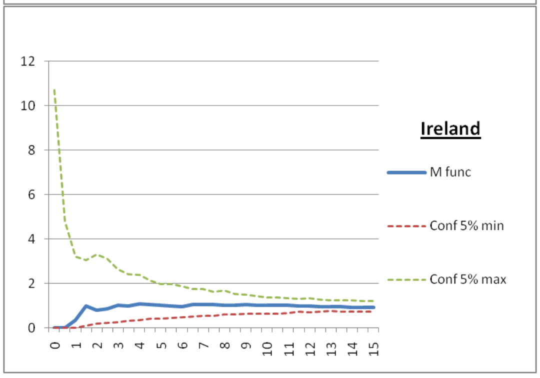

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Ireland
M func
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11.2.2 By Sector

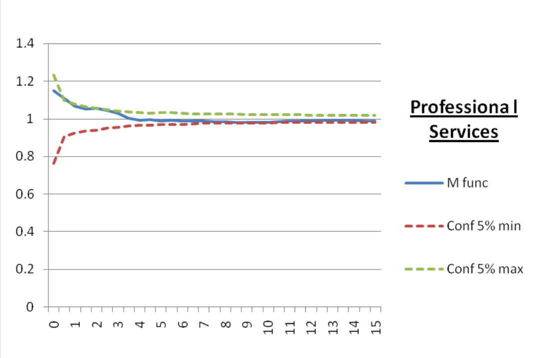
For the investigation of sectors, there was a mismatch between UKTI sector definitions, and the sector classifications used by Think London.

LDA Target Sector	Count
Environmental	6
Utilities	7
Retail	9
Higher Education and Research	11
Transport and Logistics	18
Health	21
Construction	23
Food and Drink	23
Life Sciences	23
Tourism and Leisure	33
N/A	44
ICT	74
Creative Industries	82
Financial Services	96
Professional Services	283

Think London relies on a sector classification taken from the London Development Agency's target sectors, deemed relevant to the economic makeup of London. The methodology for the development of these target sectors from custom aggregations of ABI SIC classes is detailed in the report "Understanding London's Sectors" (LDA 2003). UKTI uses a less transparent methodology for the assignment of FDI projects into a set of classes. We did a manual match between the two classes, and relied in our analysis on the LDA target sectors for analysis.

The resulting M functions exhibit some interesting patterns. Agglomeration over and above what could be expected from CSR can be observed across all distances for the Financial Industries sectors. This comes as no great surprise given the well known concentration of Financial Services for example in the City of London, and secondarily in the West End of London and Canary Wharf.

Significant concentration can also be observed for the Creative Industries and ICT, but this time only significantly along the first kilometre or so of distance.


Professiona l Services
M func
Conf 5% min
Conf 5% max
1.4
1.2
1
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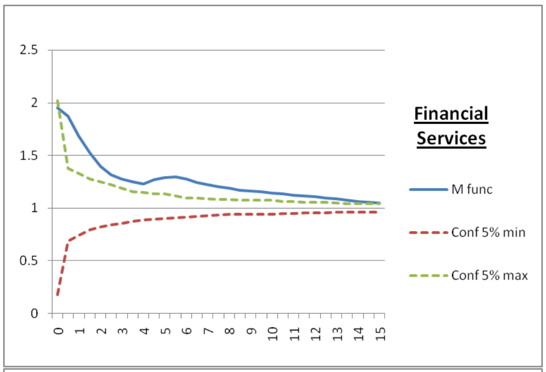
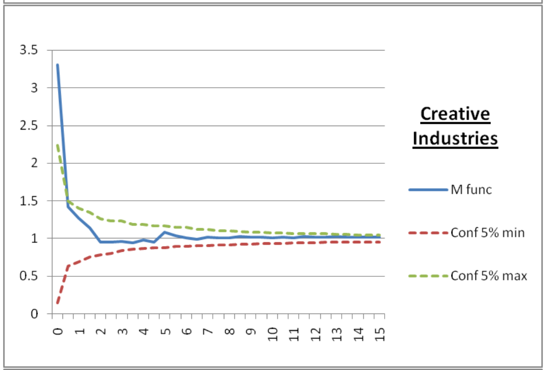
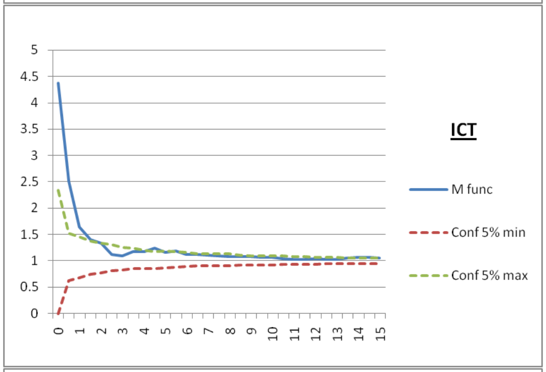
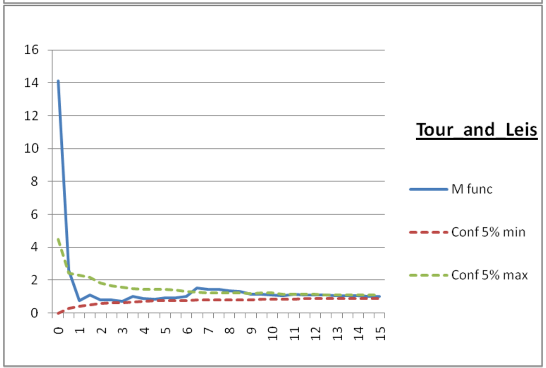

Financial Services
M func
Conf 5% min
Conf 5% max
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Creative Industries
M func
Conf 5% min
Conf 5% max
3.5
3
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


ICT
M func
Conf 5% min
Conf 5% max
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Tour_and_Leis
M func
Conf 5% min
Conf 5% max
16
14
12
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8
6
4
2
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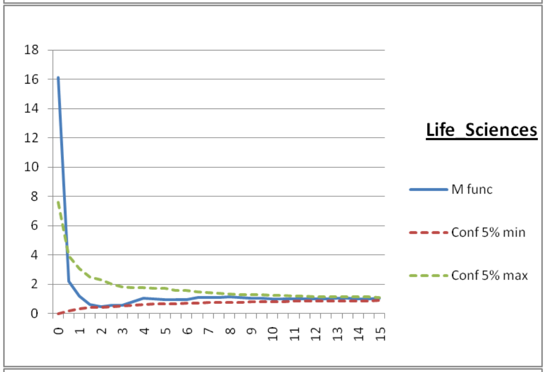
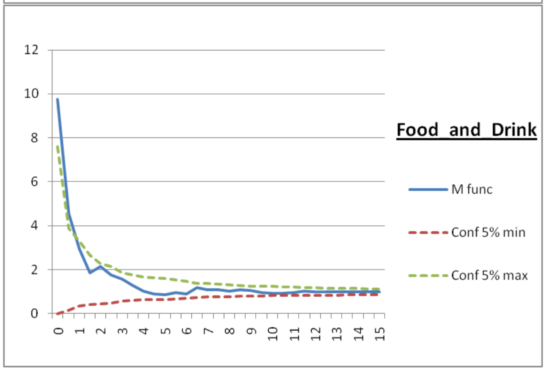
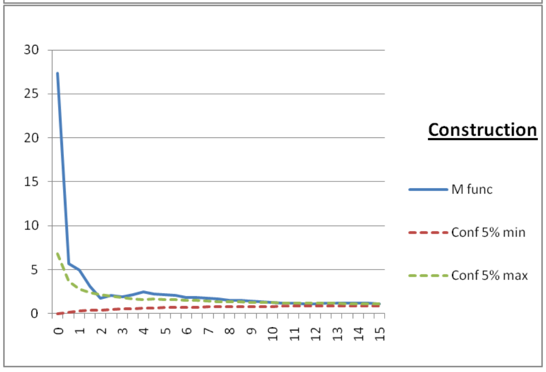
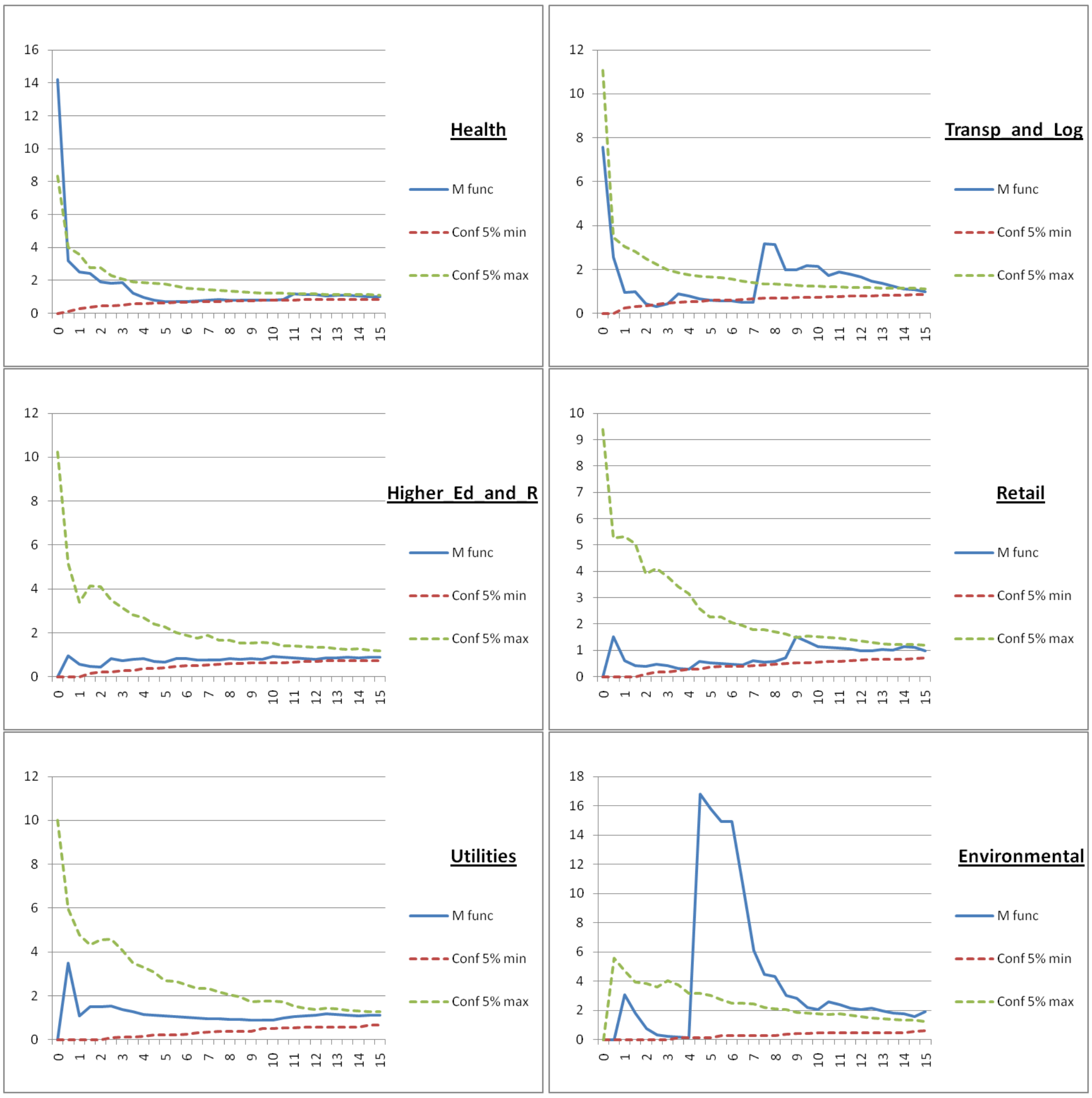
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Life_Sciences
M func
Conf 5% min
Conf 5% max
18
16
14
12
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Food_and_Drink
M func
Conf 5% min
Conf 5% max
12
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Construction
M func
Conf 5% min
Conf 5% max
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



Health
M func
Conf 5% min
Conf 5% max
Transp_and_Log
M func
Conf 5% min
Conf 5% max
Higher_Ed_and_R
M func
Conf 5% min
Conf 5% max
Retail
M func
Conf 5% min
Conf 5% max
Utilities
M func
Conf 5% min
Conf 5% max
Environmental
M func
Conf 5% min
Conf 5% max

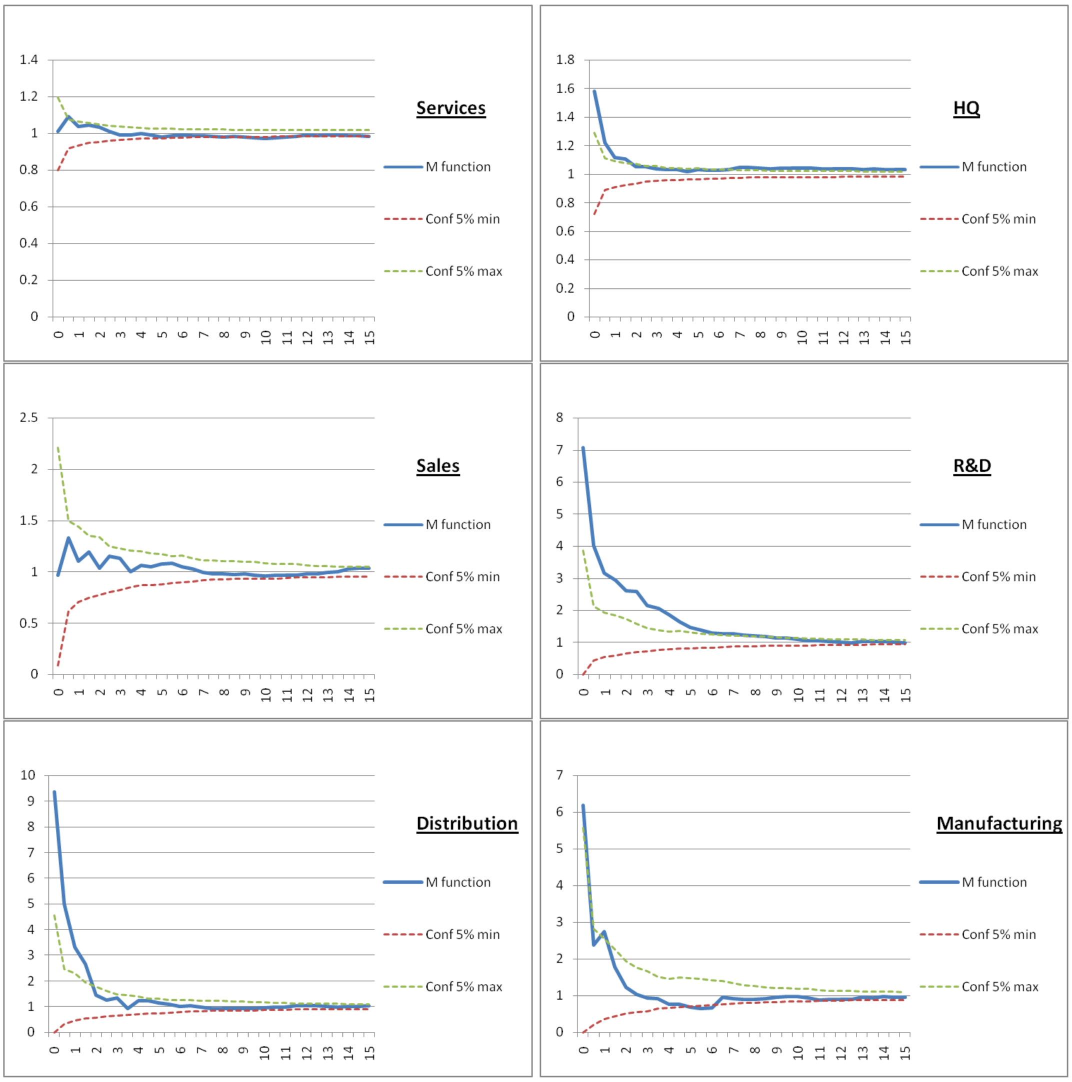
11.2.3 By function

Finally, we investigate spatial concentration or dispersion patterns according to functional classification of FDI. Again, here we are relying on the classification of function according to the UKTI data. It should be noted that, opposed to sectors (ABI SIC classification), there are no good quality “official” functional classifications.

UKTI Functional Classification	Count
Manufacturing	28
Distribution	34
Research and Development	42
Sales	76
Headquarters	248
Services	325

The overwhelming majority of FDI are classified as “services” type, be it business or consumer services type activities. Given the broad class, it is not very surprising that there doesn’t seem to be any significant concentration or dispersion of said business function over different distances.

Headquarter function foreign direct investments only display a slight concentration over a short distance, which could be explained by above average concentration of Headquarters in Central London. The M function for the sales type businesses exhibits neither marked nor significant patterns of concentration or dispersion.Research and Development on the other hand seems to exhibit marked patterns of concentration.


Services
M function
Conf 5% min
Conf 5% max
HQ
M function
Conf 5% min
Conf 5% max
Sales
M function
Conf 5% min
Conf 5% max
R&D
M function
Conf 5% min
Conf 5% max
Distribution
M function
Conf 5% min
Conf 5% max
Manufacturing
M function
Conf 5% min
Conf 5% max

11.3 Lookup table for LDA Target Sectors to SIC classes

Name of sector	Sub-sector	SIC	Description	Source of definition
Creative industries	Film	2232	Reproduction of video recording	Based on DCMS definition
Creative industries	Film	9211	Motion picture & video production	Based on DCMS definition
Creative industries	Film	9212	Motion picture & video distribution	Based on DCMS definition
Creative industries	Film	9213	Motion picture projection	Based on DCMS definition
Creative industries	Music, visual & performing arts	2214	Publishing of sound recordings	Based on DCMS definition
Creative industries	Music, visual & performing arts	2231	Reproduction of sound recording	Based on DCMS definition
Creative industries	Music, visual & performing arts	7481	Photographic activities	Based on DCMS definition
Creative industries	Music, visual & performing arts	9231	Artistic & literary creation etc	Based on DCMS definition
Creative industries	Music, visual & performing arts	9232	Operation of arts facilities	Based on DCMS definition
Creative industries	Music, visual & performing arts	9234	Other entertainment activities	Based on DCMS definition
Creative industries	Music, visual & performing arts	9272	Other recreational activities	Based on DCMS definition
Creative industries	Architecture	7420	Architectural/engineering activities	Based on DCMS definition
Creative industries	Publishing	2211	Publishing of books	Based on DCMS definition
Creative industries	Publishing	2212	Publishing of newspapers	Based on DCMS definition
Creative industries	Publishing	2213	Publishing of journals & periodicals	Based on DCMS definition
Creative industries	Publishing	2215	Other publishing	Based on DCMS definition
Creative industries	Publishing	9240	News agency activities	Based on DCMS definition
Creative industries	Computer games, software	2233	Reproduction of computer media	Based on DCMS definition
Creative industries	Computer games, software	7220	Software consultancy & supply	Based on DCMS definition
Creative industries	Radio & TV	9220	Radio & television activities	Based on DCMS definition
Creative industries	Advertising	7440	Advertising	Based on DCMS definition
Creative industries	Designer fashion	1771	Manufacture of knitted/crocheted hosiery	Based on DCMS definition
Creative industries	Designer fashion	1772	Manufacture knitted/crocheted pullovers	Based on DCMS definition
Creative industries	Designer fashion	1810	Manufacture of leather clothes	Based on DCMS definition
Creative industries	Designer fashion	1821	Manufacture of work-wear	Based on DCMS definition

Creative industries	Designer fashion	1822	Manufacture of other outerwear	Based on DCMS definition
Creative industries	Designer fashion	1823	Manufacture of underwear	Based on DCMS definition
Creative industries	Designer fashion	1824	Manufacture of other wearing apparel nec	Based on DCMS definition
Creative industries	Designer fashion	1830	Dressing & dyeing of fur	Based on DCMS definition
Creative industries	Designer fashion	1930	Manufacture of footwear	Based on DCMS definition
Creative industries	Designer fashion	7484	Other business activities nec	Based on DCMS definition
Creative industries	Craft	3622	Manufacture of jewellery nec	DCMS & London Business Link
Creative industries	Craft	3630	Manufacture of musical instruments	DCMS & London Business Link
Creative industries	Craft	2621	Manufacture ceramic household articles	DCMS & London Business Link
Creative industries	Craft	2622	Manufacture of ceramic sanitary fixtures	DCMS & London Business Link
Creative industries	Craft	3661	Manufacture of imitation jewellery	DCMS & London Business Link
Creative industries	Craft	1740	Manufacture of made-up textile articles	DCMS & London Business Link
Creative industries	Art/antiques trade	5248	Other retail sale specialised stores	Based on DCMS definition
Creative industries	Art/antiques trade	5250	Retail sale second-hand goods in stores	Based on DCMS definition
Higher education & research		8030	Higher education	Based on EBS definition
Higher education & research		73	Research and development	Based on EBS definition
Health		8511	Hospital activities	Based on EBS definition
Health		8512	Medical practice activities	Based on EBS definition
Health		8513	Dental practice activities	Based on EBS definition
Health		8514	Other human health activities	Based on EBS definition
Social work		8531	Social work activities with accom. and	Based on EBS definition
Social work		8532	Social work activities without accom.	Based on EBS definition
Tourism & leisure		All of SIC 55	Hotels and restaurants	Based on EBS definition
Tourism & leisure		6330	Activities of travel agencies etc nec	Based on EBS definition
Tourism & leisure		9251	Library & archives activities	Based on EBS definition
Tourism & leisure		9252	Museum activities etc	Based on EBS definition
Tourism & leisure		9253	Botanical & zoological gardens etc	Based on EBS definition
Tourism & leisure		9261	Operation of sports arenas & stadiums	Based on EBS definition
Tourism & leisure		9262	Other sporting activities	Based on EBS definition
Tourism & leisure		9271	Gambling & betting activities	Based on EBS definition

Tourism & leisure		9272	Other recreational activities nec	Based on EBS definition
Utilities		40	Electricity, gas, steam/hot water supply	Based on EBS definition
Utilities		41	Collection/purification of water	Based on EBS definition
Professional services		7413	Market research/opinion polling	Based on DTI definition
Professional services		7411	Legal activities	Based on DTI definition
Professional services		7414	General management consultancy	Based on DTI definition
Professional services		7415	Management Activities Holding Companies	Based on DTI definition
Professional services		7484	Other business activity	Based on DTI definition
Professional services		7483	Secretarial/translation services	Based on DTI definition
Professional services		7412	Book keeping services	Based on DTI definition
Financial services	City	6523	Other financial intermediation nec	Based on EBS definition
Financial services	City	6712	Security broking & fund management	Based on EBS definition
Financial services	City	6713	Activ. auxil. to fin. intermediation nec	Based on EBS definition
Financial services	City	6720	Activ. auxil. to insur./pension funding	Based on EBS definition
Financial services	City	6602	Pension funding	Based on EBS definition
Financial services	City	6603	Non-life insurance	Based on EBS definition
Financial services	City	6511	Central banking	Based on EBS definition
Financial services	City	6711	Administration of financial markets	Based on EBS definition
Financial services	City	7414	Business/management consultancy activ.	Based on EBS definition
Financial services	City	6521	Financial leasing	Based on EBS definition
Financial services	City	6512	Other monetary intermediation –	Based on EBS definition
Financial services	Non-City	7412	Accounting/book-keeping activities etc	Based on EBS definition
Financial services	Non-City	7484	Other business activities nec	Based on EBS definition
Financial services	Non-City	6522	Other credit granting	Based on EBS definition
Financial services	Non-City	6512	Other monetary intermediation –	Based on EBS definition
Food & drink	Manufacture	All of SIC 15	Manufacture of food products and beverages	Based on EBS definition
Food & drink	Retail	5221-5227	Retail sale of food & drink	Based on EBS definition
ICT		3001	Manufacture of office machinery	Based on OECD definition
ICT		3002	Manufacture of computers etc	Based on OECD definition
ICT		3130	Manufacture of insulated wire & cable	Based on OECD

			definition
ICT	3210	Manufacture of electronic valves etc	Based on OECD definition
ICT	3220	Manufacture of TV/radio transmitters etc	Based on OECD definition
ICT	3230	Manufacture of TV/radio receivers etc	Based on OECD definition
ICT	3320	Manufacture of instruments for measuring etc	Based on OECD definition
ICT	3330	Manufacture of industrial process control equip.	Based on OECD definition
ICT	5164	Wholesale office machinery & equip.	Based on OECD definition
ICT	6420	Telecommunications	Based on OECD definition
ICT	7210	Hardware consultancy	Based on OECD definition
ICT	7220	Software consultancy & supply	Based on OECD definition
ICT	7230	Data processing	Based on OECD definition
ICT	7240	Database activities	Based on OECD definition
ICT	7250	Maintenance/repair office machinery etc	Based on OECD definition
ICT	7260	Other computer related activities	Based on OECD definition
Environmental	3710	Recycling of metal waste & scrap	Encompasses LDA definition
Environmental	3720	Recycling of non-metal waste & scrap	Encompasses LDA definition
Environmental	9000	Sewage & refuse disposal etc	Encompasses LDA definition
Environmental	9133	Activit other membership organis. Nec	Encompasses LDA definition
Environmental	7512	Regulation education agencies etc	Encompasses LDA definition
Environmental	7420	Architectural/engineering activities	Encompasses LDA definition
Construction	All of SIC 45	Construction	Based on EBS definition
Retail	All of SIC 52	Retail, except of motor vehicles & motorcycles; repair of personal & household goods	Based on EBS definition
Transport & logistics	60, 61, 62, 63	Land, water, air transport and Supporting/auxiliary transport, etc.	Based on EBS definition
Transport & logistics	51	Wholesale trade/commission trade, etc	Based on EBS definition
Charity & voluntary	9133	Activities other membership organis. nec	Based on EBS definition
Charity & voluntary	8532	Social work activities without accom.	Based on EBS definition
Life sciences	7310	Research and development natural sciences/engineering	Suggested by LDA
Pharmaceuticals	2441	Manufacture of pharmaceutical products	Suggested by LDA
Pharmaceuticals	2442	Manufacture pharmaceutical preparations	Suggested by LDA
Pharmaceuticals	5146	Wholesale of pharmaceutical goods	Suggested by LDA
Medical equipment	5232	Retail sale of medical/orthopaedic goods	Suggested by LDA

Medical equipment	3310	Manufacture of medical/surgical equipment	Suggested by LDA
Manufacturing	All SICs between 15 and 37		Based on EBS definition
Real estate	70	Real estate activities	Based on EBS definition

11.4 PCA analysis

11.4.1 Correlation Matrix of considered variables

	Smallemployers & own account w	Semiroutine occupations	Routineoccupations	Lower supervisory and technical o	Lower managerial and professiona	Large employers and higher mana	Intermediate occupations	Higher professional occupations	Fulltime student	Ratio Employment over Workplace	Charity & Voluntary	Construction	Environmental	Financial Services	Food & Drink	Healthcare	Higher Education and Research
Smallemployers & own account w	1.0	0.3	0.2	0.0	-0.3	-0.6	-0.6	-0.5	0.1	-0.6	0.2	0.3	-0.1	-0.3	0.3	0.0	-0.2
Semiroutine occupations	0.3	1.0	0.4	0.5	-0.7	-0.6	-0.1	-0.7	0.6	-0.2	0.0	0.2	-0.2	-0.4	0.2	0.0	-0.1
Routineoccupations	0.2	0.4	1.0	0.7	-0.6	-0.4	-0.3	-0.6	0.0	-0.1	0.1	0.3	-0.1	-0.5	0.4	0.0	-0.1
Lower supervisory and technical o	0.0	0.5	0.7	1.0	-0.6	-0.3	-0.2	-0.6	0.0	0.1	0.0	0.3	-0.1	-0.4	0.2	-0.1	-0.1
Lower managerial and professiona	-0.3	-0.7	-0.6	-0.6	1.0	0.4	0.0	0.6	-0.3	0.0	0.1	-0.4	0.2	0.2	-0.3	0.1	0.2
Large employers and higher mana	-0.6	-0.6	-0.4	-0.3	0.4	1.0	0.3	0.6	-0.4	0.4	-0.2	-0.2	0.2	0.5	-0.2	-0.2	0.0
Intermediate occupations	-0.6	-0.1	-0.3	-0.2	0.0	0.3	1.0	0.2	0.0	0.5	-0.1	-0.1	0.0	0.3	-0.2	0.0	-0.1
Higher professional occupations	-0.5	-0.7	-0.6	-0.6	0.6	0.6	0.2	1.0	-0.3	0.2	-0.2	-0.4	0.2	0.6	-0.2	0.2	0.4
Fulltime student	0.1	0.6	0.0	0.0	-0.3	-0.4	0.0	-0.3	1.0	-0.1	0.0	0.0	-0.1	-0.2	-0.1	0.0	0.0
Ratio Employment over Workplace	-0.6	-0.2	-0.1	0.1	0.0	0.4	0.5	0.2	-0.1	1.0	-0.2	-0.1	-0.1	0.3	-0.2	0.0	0.1
Charity & Voluntary	0.2	0.0	0.1	0.0	0.1	-0.2	-0.1	-0.2	0.0	-0.2	1.0	0.0	0.1	-0.2	0.0	-0.1	-0.1
Construction	0.3	0.2	0.3	0.3	-0.4	-0.2	-0.1	-0.4	0.0	-0.1	0.0	1.0	0.0	-0.2	0.1	-0.1	-0.2
Environmental	-0.1	-0.2	-0.1	-0.1	0.2	0.2	0.0	0.2	-0.1	-0.1	0.1	0.0	1.0	0.0	0.1	-0.2	0.0
Financial Services	-0.3	-0.4	-0.5	-0.4	0.2	0.5	0.3	0.6	-0.2	0.3	-0.2	-0.2	0.0	1.0	-0.2	-0.2	-0.1
Food & Drink	0.3	0.2	0.4	0.2	-0.3	-0.2	-0.2	-0.2	-0.1	-0.2	0.0	0.1	0.1	-0.2	1.0	-0.1	-0.1
Healthcare	0.0	0.0	0.0	-0.1	0.1	-0.2	0.0	0.2	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.1	1.0	0.2
Higher Education and Research	-0.2	-0.1	-0.1	-0.1	0.2	0.0	-0.1	0.4	0.0	0.1	-0.1	-0.2	0.0	-0.1	-0.1	0.2	1.0
ICT	-0.1	-0.2	-0.1	0.0	0.0	0.3	0.1	0.2	-0.1	0.0	-0.1	0.1	0.2	0.1	-0.1	-0.2	-0.1
Life Sciences	-0.1	-0.1	0.0	0.0	0.0	0.1	-0.1	0.3	-0.1	0.0	-0.1	-0.1	0.2	0.0	0.0	0.0	0.3
Creative Industries	0.0	-0.3	-0.3	-0.3	0.5	0.3	-0.2	0.2	0.0	-0.2	0.1	-0.1	0.4	0.0	-0.1	-0.3	-0.1
Manufacturing	0.0	0.1	0.5	0.6	-0.4	0.0	-0.2	-0.2	-0.2	-0.1	0.0	0.2	0.2	-0.2	0.4	-0.2	-0.1
Medical Equipment	0.1	0.1	0.1	0.0	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.1	-0.1	0.0	0.2	0.0	-0.1
Pharmaceuticals	-0.1	0.0	0.1	0.0	-0.1	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	-0.1	0.0	0.1	0.0
Professional Services	-0.1	-0.5	-0.5	-0.5	0.4	0.5	0.1	0.5	-0.2	-0.1	-0.2	-0.2	0.1	0.5	-0.1	-0.2	0.0
Real Estate	0.1	-0.1	-0.2	-0.3	0.3	-0.1	-0.2	0.0	0.1	-0.3	0.0	-0.3	0.0	0.0	0.0	0.0	0.0
Retail	0.2	0.6	0.0	0.1	-0.3	-0.3	-0.1	-0.4	0.8	-0.2	0.0	-0.1	-0.1	-0.2	0.0	-0.1	-0.1
SocialWork	0.4	0.1	0.0	-0.1	0.0	-0.3	-0.2	-0.2	0.0	-0.3	0.8	0.0	-0.1	-0.2	0.0	0.0	-0.1
Tourism and Leisure	0.2	0.0	-0.1	-0.1	0.2	-0.1	-0.3	-0.1	0.1	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0
Transport and Logistics	-0.2	-0.1	0.3	0.4	-0.2	0.2	0.1	-0.1	-0.2	0.4	-0.1	0.1	0.0	-0.2	0.1	-0.1	-0.1
Utilities	-0.1	0.1	0.0	0.0	-0.1	0.0	0.1	0.1	0.2	0.2	-0.2	-0.1	-0.1	0.0	-0.1	0.2	0.0
IMD07 Score	-0.2	0.1	0.4	0.3	-0.1	-0.1	0.0	-0.2	-0.2	0.1	0.5	-0.1	0.0	-0.2	0.1	0.0	0.0
IMD07 Income Score	-0.1	0.1	0.5	0.3	-0.2	-0.1	0.1	-0.2	-0.2	0.1	0.4	0.0	0.0	-0.2	0.2	0.0	0.0
IMD07 Employment Score	-0.1	0.1	0.4	0.3	-0.2	-0.1	0.0	-0.2	-0.2	0.1	0.5	0.0	0.0	-0.2	0.2	0.0	-0.1
IMD07 Health Score	-0.1	0.1	0.3	0.2	-0.1	-0.1	0.0	-0.2	-0.1	0.1	0.4	0.0	0.0	-0.2	0.1	0.0	-0.1
IMD07 Education Score	-0.2	0.3	0.6	0.5	-0.3	-0.1	0.1	-0.3	-0.2	0.2	0.2	0.1	0.0	-0.2	0.1	0.0	-0.1
IMD07 Housing Services Score	-0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.2	0.2	-0.3	-0.1	0.0	0.0	-0.1	0.0
IMD07 Crime Score	0.1	0.3	0.4	0.3	-0.2	-0.4	-0.1	-0.5	0.1	-0.2	0.4	0.1	-0.1	-0.5	0.2	0.2	-0.1
IMD07 Living Environment Score	-0.2	-0.2	0.0	-0.1	0.4	0.1	-0.1	0.1	-0.2	0.0	0.3	-0.2	0.1	-0.1	0.0	-0.1	0.1
CentralLondon	0.3	0.5	0.3	0.3	-0.5	-0.4	0.0	-0.5	0.2	-0.1	0.0	0.3	-0.1	-0.3	0.1	0.0	-0.1
Heathrow	0.3	0.5	0.2	0.1	-0.4	-0.5	-0.1	-0.3	0.2	-0.2	0.1	0.2	-0.1	-0.1	0.1	0.2	0.0
RVperSqM_All_Bulk	-0.4	-0.3	-0.5	-0.3	0.5	0.5	0.1	0.4	0.0	0.1	-0.3	-0.4	0.0	0.4	-0.2	-0.1	0.1
RVperSqM_Offices	-0.5	-0.5	-0.5	-0.3	0.6	0.6	0.2	0.6	-0.2	0.2	-0.2	-0.3	0.2	0.4	-0.2	-0.1	0.1
RVperSqM_Retail_Premises	-0.4	-0.3	-0.4	-0.3	0.4	0.4	0.1	0.4	0.0	0.1	-0.2	-0.3	0.0	0.4	-0.2	-0.1	0.0
RVperSqM_Factories	0.0	-0.1	0.0	0.1	0.1	0.0	0.0	-0.1	-0.1	0.1	0.3	0.1	0.0	-0.2	0.0	0.0	-0.1
RVperSqM_Warehouses	-0.3	-0.1	0.0	0.1	0.0	0.2	0.3	0.1	-0.1	0.4	0.0	-0.1	-0.1	0.1	0.0	-0.1	0.0
LQFloorspaceOffices	-0.6	-0.6	-0.6	-0.4	0.5	0.7	0.5	0.6	-0.3	0.4	-0.2	-0.2	0.2	0.5	-0.3	-0.1	0.0
LQFloorspaceRetailPremises	0.4	0.5	0.1	0.0	-0.3	-0.5	-0.2	-0.3	0.5	-0.3	0.0	0.0	-0.1	-0.2	0.1	0.1	-0.1
LQFloorspaceFactories	0.0	0.1	0.4	0.3	-0.2	-0.1	-0.1	-0.2	-0.1	0.0	0.2	0.2	-0.1	-0.2	0.1	0.1	0.0
LQFloorspaceWarehouses	-0.1	0.1	0.5	0.4	-0.2	0.0	0.0	-0.2	-0.2	0.1	0.1	0.1	0.0	-0.2	0.1	-0.1	0.0

	ICT	Life Sciences	Creative Industries	Manufacturing	Medical Equipment	Pharmaceuticals	Professional Services	Real Estate	Retail	SocialWork	Tourism and Leisure	Transport and Logistics	Utilities	IMD07 Score	IMD07 Income Score	IMD07 Employment Score	IMD07 Health Score
Smallemployers & own account w	-0.1	-0.1	0.0	0.0	0.1	-0.1	-0.1	0.1	0.2	0.4	0.2	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1
Semiroutine occupations	-0.2	-0.1	-0.3	0.1	0.1	0.0	-0.5	-0.1	0.6	0.1	0.0	-0.1	0.1	0.1	0.1	0.1	0.1
Routineoccupations	-0.1	0.0	-0.3	0.5	0.1	0.1	-0.5	-0.2	0.0	0.0	-0.1	0.3	0.0	0.4	0.5	0.4	0.3
Lower supervisory and technical o	0.0	0.0	-0.3	0.6	0.0	0.0	-0.5	-0.3	0.1	-0.1	-0.1	0.4	0.0	0.3	0.3	0.3	0.2
Lower managerial and professiona	0.0	0.0	0.5	-0.4	-0.1	-0.1	0.4	0.3	-0.3	0.0	0.2	-0.2	-0.1	-0.1	-0.2	-0.2	-0.1
Large employers and higher mana	0.3	0.1	0.3	0.0	-0.1	0.1	0.5	-0.1	-0.3	-0.3	-0.1	0.2	0.0	-0.1	-0.1	-0.1	-0.1
Intermediate occupations	0.1	-0.1	-0.2	-0.2	0.0	0.0	0.1	-0.2	-0.1	-0.2	-0.3	0.1	0.1	0.0	0.1	0.0	0.0
Higher professional occupations	0.2	0.3	0.2	-0.2	-0.1	0.0	0.5	0.0	-0.4	-0.2	-0.1	-0.1	0.1	-0.2	-0.2	-0.2	-0.2
Fulltime student	-0.1	-0.1	0.0	-0.2	0.0	-0.1	-0.2	0.1	0.8	0.0	0.1	-0.2	0.2	-0.2	-0.2	-0.2	-0.1
Ratio Employment over Workplace	0.0	0.0	-0.2	-0.1	-0.1	0.0	-0.1	-0.3	-0.2	-0.3	-0.2	0.4	0.2	0.1	0.1	0.1	0.1
Charity & Voluntary	-0.1	-0.1	0.1	0.0	0.0	-0.1	-0.2	0.0	0.0	0.8	0.0	-0.1	-0.2	0.5	0.4	0.5	0.4
Construction	0.1	-0.1	-0.1	0.2	0.1	0.0	-0.2	-0.3	-0.1	0.0	-0.1	0.1	-0.1	-0.1	0.0	0.0	0.0
Environmental	0.2	0.2	0.4	0.2	-0.1	-0.1	0.1	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
Financial Services	0.1	0.0	0.0	-0.2	0.0	-0.1	0.5	0.0	-0.2	-0.2	-0.1	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
Food & Drink	-0.1	0.0	-0.1	0.4	0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	0.2	0.2	0.1
Healthcare	-0.2	0.0	-0.3	-0.2	0.0	0.1	-0.2	0.0	-0.1	0.0	-0.2	-0.1	0.2	0.0	0.0	0.0	0.0
Higher Education and Research	-0.1	0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1
ICT	1.0	0.1	0.2	0.1	0.0	0.0	0.2	-0.1	-0.2	-0.2	-0.1	0.2	0.0	-0.2	-0.1	-0.1	-0.1
Life Sciences	0.1	1.0	0.1	0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Creative Industries	0.2	0.1	1.0	0.1	0.0	-0.1	0.3	0.2	0.1	0.0	0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Manufacturing	0.1	0.1	0.1	1.0	0.1	0.1	-0.2	-0.2	-0.2	-0.1	-0.2	0.1	-0.1	0.2	0.3	0.3	0.2
Medical Equipment	0.0	0.0	0.0	0.1	1.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0
Pharmaceuticals	0.0	0.0	-0.1	0.1	0.1	1.0	-0.1	-0.1	-0.1	-0.1	-0.2	0.2	0.0	-0.1	0.0	-0.1	0.0
Professional Services	0.2	0.0	0.3	-0.2	0.1	-0.1	1.0	0.2	-0.2	-0.1	0.1	-0.2	-0.1	-0.3	-0.3	-0.3	-0.3
Real Estate	-0.1	-0.1	0.2	-0.2	0.1	-0.1	0.2	1.0	0.1	0.1	0.2	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2
Retail	-0.2	-0.1	0.1	-0.2	0.0	-0.1	-0.2	0.1	1.0	-0.1	0.2	-0.2	0.2	-0.1	-0.1	-0.1	-0.2
SocialWork	-0.2	-0.1	0.0	-0.1	0.1	-0.1	-0.1	0.1	-0.1	1.0	0.0	-0.2	-0.1	0.2	0.2	0.3	0.3
Tourism and Leisure	-0.1	0.0	0.2	-0.2	0.0	-0.2	0.1	0.2	0.2	0.0	1.0	-0.2	-0.1	-0.2	-0.3	-0.3	-0.3
Transport and Logistics	0.2	0.0	-0.1	0.1	0.0	0.2	-0.2	-0.1	-0.2	-0.2	-0.2	1.0	0.0	0.2	0.2	0.2	0.2
Utilities	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	0.2	-0.1	-0.1	0.0	1.0	0.0	0.0	0.0	0.0
IMD07 Score	-0.2	-0.1	-0.1	0.2	-0.1	-0.1	-0.3	-0.1	-0.1	0.2	-0.2	0.2	0.0	1.0	1.0	0.9	0.9
IMD07 Income Score	-0.1	-0.1	-0.1	0.3	0.0	0.0	-0.3	-0.2	-0.1	0.2	-0.3	0.2	0.0	1.0	1.0	0.9	0.9
IMD07 Employment Score	-0.1	-0.1	-0.1	0.3	0.0	-0.1	-0.3	-0.2	-0.1	0.3	-0.3	0.2	0.0	0.9	0.9	1.0	0.9
IMD07 Health Score	-0.1	-0.1	-0.1	0.2	0.0	0.0	-0.3	-0.2	-0.2	0.3	-0.3	0.2	0.0	0.9	0.9	0.9	1.0
IMD07 Education Score	-0.1	-0.1	-0.2	0.5	-0.1	0.1	-0.4	-0.3	-0.1	0.0	-0.2	0.3	0.0	0.8	0.8	0.8	0.7
IMD07 Housing Services Score	-0.2	0.0	0.1	-0.1	-0.1	-0.1	-0.1	0.2	0.1	0.1	0.0	0.1	0.0	0.6	0.5	0.4	0.4
IMD07 Crime Score	-0.2	-0.1	-0.1	0.1	0.0	0.0	-0.5	0.0	0.1	0.3	-0.1	0.1	0.0	0.6	0.6	0.6	0.6
IMD07 Living Environment Score	-0.2	-0.1	0.2	0.0	-0.1	-0.1	0.0	0.1	0.0	0.1	0.1	-0.1	-0.1	0.6	0.4	0.5	0.5
CentralLondon	0.1	0.1	-0.3	0.1	0.1	0.1	-0.3	-0.2	0.1	0.1	-0.2	0.1	0.1	-0.2	-0.1	-0.1	-0.1
Heathrow	-0.2	0.0	-0.3	0.0	0.1	-0.1	-0.2	-0.1	0.1	0.2	-0.2	-0.3	0.1	0.0	0.0	0.0	0.1
RVperSqM_All_Bulk	0.0	0.0	0.3	-0.2	-0.1	-0.1	0.4	0.2	0.2	-0.3	0.4	-0.1	0.0	-0.3	-0.4	-0.4	-0.5
RVperSqM_Offices	0.1	0.0	0.3	-0.2	-0.1	-0.1	0.5	0.1	-0.1	-0.3	0.3	0.0	0.0	-0.2	-0.3	-0.3	-0.4
RVperSqM_Retail_Premises	0.0	0.0	0.3	-0.2	-0.1	-0.1	0.3	0.2	0.2	-0.3	0.3	-0.1	0.0	-0.2	-0.3	-0.3	-0.4
RVperSqM_Factories	0.1	0.0	0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1	0.1	-0.2	0.3	0.0	0.3	0.3	0.3	0.4
RVperSqM_Warehouses	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	0.0	0.3	0.0	0.2	0.1	0.2	0.1
LQFloorspaceOffices	0.2	0.0	0.2	-0.2	-0.1	-0.1	0.5	0.0	-0.3	-0.2	0.1	0.0	0.0	-0.2	-0.2	-0.2	-0.2
LQFloorspaceRetailPremises	-0.3	0.0	-0.1	-0.1	0.0	-0.1	-0.2	0.1	0.5	0.1	0.2	-0.3	0.0	-0.1	-0.2	-0.2	-0.2
LQFloorspaceFactories	0.1	-0.1	-0.1	0.2	0.0	0.1	-0.3	-0.2	-0.1	0.1	-0.2	0.2	0.1	0.4	0.5	0.4	0.4
LQFloorspaceWarehouses	0.1	0.1	-0.2	0.3	0.0	0.1	-0.3	-0.1	-0.1	0.0	-0.3	0.4	0.0	0.4	0.4	0.4	0.4

	IMD07 Education Score	IMD07 Housing Services Score	IMD07 Crime Score	IMD07 Living Environment Score	CentralLondon		Heathrow	RVperSqM_All_Bulk	RVperSqM_Offices	RVperSqM_Retail_Premises	RVperSqM_Factories	RVperSqM_Warehouses	LQFloorspaceOffices	LQFloorspaceRetailPremises	LQFloorspaceFactories	LQFloorspaceWarehouses
Smallemployers & own account w	-0.2	-0.2	0.1	-0.2	0.3	0.4	0.3	-0.4	-0.5	-0.4	0.0	-0.3	-0.6	0.4	0.0	-0.1
Semiroutine occupations	0.3	0.0	0.3	-0.2	0.5	0.5	0.5	-0.3	-0.5	-0.3	-0.1	-0.1	-0.6	0.5	0.1	0.1
Routineoccupations	0.6	0.0	0.4	0.0	0.3	0.3	0.2	-0.5	-0.5	-0.4	0.0	0.0	-0.6	0.1	0.4	0.5
Lower supervisory and technical o	0.5	0.0	0.3	-0.1	0.3	0.3	0.1	-0.3	-0.3	-0.3	0.1	0.1	-0.4	0.0	0.3	0.4
Lower managerial and professiona	-0.3	0.1	-0.2	0.4	-0.5	-0.5	-0.4	0.5	0.6	0.4	0.1	0.0	0.5	-0.3	-0.2	-0.2
Large employers and higher mana	-0.1	0.0	-0.4	0.1	-0.4	-0.4	-0.5	0.5	0.6	0.4	0.0	0.2	0.7	-0.5	-0.1	0.0
Intermediate occupations	0.1	0.1	-0.1	-0.1	0.0	-0.1	-0.1	0.1	0.2	0.1	0.0	0.3	0.5	-0.2	-0.1	0.0
Higher professional occupations	-0.3	0.1	-0.5	0.1	-0.5	-0.5	-0.3	0.4	0.6	0.4	-0.1	0.1	0.6	-0.3	-0.2	-0.2
Fulltime student	-0.2	0.0	0.1	-0.2	0.2	0.3	0.2	0.0	-0.2	0.0	-0.1	-0.1	-0.3	0.5	-0.1	-0.2
Ratio Employment over Workplace	0.2	0.2	-0.2	0.0	-0.1	-0.1	-0.2	0.1	0.2	0.1	0.1	0.4	0.4	-0.3	0.0	0.1
Charity & Voluntary	0.2	0.2	0.4	0.3	0.0	0.0	0.1	-0.3	-0.2	-0.2	0.3	0.0	-0.2	0.0	0.2	0.1
Construction	0.1	-0.3	0.1	-0.2	0.3	0.4	0.2	-0.4	-0.3	-0.3	0.1	-0.1	-0.2	0.0	0.2	0.1
Environmental	0.0	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	0.0	0.2	0.0	0.0	-0.1	0.2	-0.1	-0.1	0.0
Financial Services	-0.2	0.0	-0.5	-0.1	-0.3	-0.3	-0.1	0.4	0.4	0.4	-0.2	0.1	0.5	-0.2	-0.2	-0.2
Food & Drink	0.1	0.0	0.2	0.0	0.1	0.1	0.1	-0.2	-0.2	-0.2	0.0	0.0	-0.3	0.1	0.1	0.1
Healthcare	0.0	-0.1	0.2	-0.1	0.0	0.1	0.2	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	0.1	0.1	-0.1
Higher Education and Research	-0.1	0.0	-0.1	0.1	-0.1	-0.1	0.0	0.1	0.1	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0
ICT	-0.1	-0.2	-0.2	-0.2	0.1	0.1	-0.2	0.0	0.1	0.0	0.1	0.1	0.2	-0.3	0.1	0.1
Life Sciences	-0.1	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	0.1
Creative Industries	-0.2	0.1	-0.1	0.2	-0.3	-0.3	-0.3	0.3	0.3	0.3	0.1	0.0	0.2	-0.1	-0.1	-0.2
Manufacturing	0.5	-0.1	0.1	0.0	0.1	0.1	0.0	-0.2	-0.2	-0.2	0.0	0.0	-0.2	-0.1	0.2	0.3
Medical Equipment	-0.1	-0.1	0.0	-0.1	0.1	0.1	0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0
Pharmaceuticals	0.1	-0.1	0.0	-0.1	0.1	0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	0.1	0.1
Professional Services	-0.4	-0.1	-0.5	0.0	-0.3	-0.2	-0.2	0.4	0.5	0.3	-0.1	-0.1	0.5	-0.2	-0.3	-0.3
Real Estate	-0.3	0.2	0.0	0.1	-0.2	-0.1	-0.1	0.2	0.1	0.2	-0.1	-0.2	0.0	0.1	-0.2	-0.1
Retail	-0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.2	-0.1	0.2	-0.1	-0.1	-0.3	0.5	-0.1	-0.1
SocialWork	0.0	0.1	0.3	0.1	0.1	0.1	0.2	-0.3	-0.3	-0.3	0.1	-0.1	-0.2	0.1	0.1	0.0
Tourism and Leisure	-0.2	0.0	-0.1	0.1	-0.2	-0.2	-0.2	0.4	0.3	0.3	-0.2	0.0	0.1	0.2	-0.2	-0.3
Transport and Logistics	0.3	0.1	0.1	-0.1	0.1	0.0	-0.3	-0.1	0.0	-0.1	0.3	0.3	0.0	-0.3	0.2	0.4
Utilities	0.0	0.0	0.0	-0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
IMD07 Score	0.8	0.6	0.6	0.6	-0.2	-0.3	0.0	-0.3	-0.2	-0.2	0.3	0.2	-0.2	-0.1	0.4	0.4
IMD07 Income Score	0.8	0.5	0.6	0.4	-0.1	-0.2	0.0	-0.4	-0.3	-0.3	0.3	0.1	-0.2	-0.2	0.5	0.4
IMD07 Employment Score	0.8	0.4	0.6	0.5	-0.1	-0.2	0.0	-0.4	-0.3	-0.3	0.3	0.2	-0.2	-0.2	0.4	0.4
IMD07 Health Score	0.7	0.4	0.6	0.5	-0.1	-0.2	0.1	-0.5	-0.4	-0.4	0.4	0.1	-0.2	-0.2	0.4	0.4
IMD07 Education Score	1.0	0.2	0.5	0.3	0.0	0.0	0.1	-0.3	-0.3	-0.2	0.2	0.2	-0.2	-0.1	0.4	0.5
IMD07 Housing Services Score	0.2	1.0	0.2	0.5	-0.4	-0.4	-0.2	0.2	0.0	0.2	0.1	0.2	0.1	0.0	0.1	0.1
IMD07 Crime Score	0.5	0.2	1.0	0.3	0.1	0.1	0.2	-0.5	-0.5	-0.4	0.3	0.0	-0.5	0.2	0.4	0.3
IMD07 Living Environment Score	0.3	0.5	0.3	1.0	-0.5	-0.5	-0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.0	0.2	0.0
CentralLondon	0.0	-0.4	0.1	-0.5	1.0	0.8	0.4	-0.5	-0.4	-0.4	0.1	0.0	-0.4	0.2	0.1	0.1
Heathrow	0.1	-0.2	0.2	-0.2	0.4	0.5	1.0	-0.4	-0.4	-0.4	-0.1	-0.2	-0.4	0.2	0.1	0.1
RVperSqM_All_Bulk	-0.3	0.2	-0.5	0.2	-0.5	-0.5	-0.4	1.0	0.7	0.9	-0.2	0.1	0.6	0.1	-0.4	-0.4
RVperSqM_Offices	-0.3	0.0	-0.5	0.2	-0.4	-0.5	-0.4	0.7	1.0	0.7	0.0	0.3	0.8	-0.3	-0.2	-0.2
RVperSqM_Retail_Premises	-0.2	0.2	-0.4	0.3	-0.4	-0.4	-0.4	0.9	0.7	1.0	-0.2	0.2	0.5	0.1	-0.3	-0.2
RVperSqM_Factories	0.2	0.1	0.3	0.2	0.1	0.0	-0.1	-0.2	0.0	-0.2	1.0	0.4	0.0	-0.2	0.5	0.3
RVperSqM_Warehouses	0.2	0.2	0.0	0.1	0.0	-0.1	-0.2	0.1	0.3	0.2	0.4	1.0	0.3	-0.2	0.1	0.4
LQFloorspaceOffices	-0.2	0.1	-0.5	0.1	-0.4	-0.4	-0.4	0.6	0.8	0.5	0.0	0.3	1.0	-0.4	-0.3	-0.3
LQFloorspaceRetailPremises	-0.1	0.0	0.2	0.0	0.2	0.2	0.2	0.1	-0.3	0.1	-0.2	-0.2	-0.4	1.0	-0.3	-0.4
LQFloorspaceFactories	0.4	0.1	0.4	0.2	0.1	0.1	0.1	-0.4	-0.2	-0.3	0.5	0.1	-0.3	-0.3	1.0	0.5
LQFloorspaceWarehouses	0.5	0.1	0.3	0.0	0.1	0.1	0.1	-0.4	-0.2	-0.2	0.3	0.4	-0.3	-0.4	0.5	1.0

11.4.2 SPSS input parameters for PCA analysis:

Output Created		23-Jun-2009 15:43:11
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	208
Missing Value Handling	Definition of Missing	MISSING=EXCLUDE: User-defined missing values are treated as missing.
	Cases Used	PAIRWISE: Correlation coefficients for each pair of variables are based on all the cases with valid data for that pair. The factor analysis is based on these correlations.
Syntax		FACTOR /VARIABLES SmallemployersandownaccountworkersAllpeople1 SemiroutineoccupationsAllpeople1 RoutineoccupationsAllpeople1 LowersupervisoryandtechnicaloccupationsAllpeople1 LowermanagerialandprofessionaloccupationsAllpeople1 LargeemployersandhighermanagerialoccupationsAllpeople1 IntermediateoccupationsAllpeople1 HigherprofessionaloccupationsAllpeople1 FulltimestudentAllpeople1 CharityandVoluntary1 Construction1 Environmental1 FinancialServices1 FoodandDrink1 Healthcare1 HigherEducationandResearch1 ICT1 LifeSciences1 CreativeIndustries1 Manufacturing1 MedicalEquipment1 Pharmaceuticals1 ProfessionalServices1 RealEstate1 Retail1 SocialWork1 TourismandLeisure1 TransportandLogistics1 Utilities1 IMD07Score RVperSqM_Offices RVperSqM_Retail_Premises RVperSqM_Factories RVperSqM_Warehouses LQFloorspaceOffices LQFloorspaceRetailPremises LQFloorspaceFactories LQFloorspaceWarehouses RatioEmpl_Workpl /MISSING PAIRWISE /ANALYSIS SmallemployersandownaccountworkersAllpeople1 SemiroutineoccupationsAllpeople1 RoutineoccupationsAllpeople1 LowersupervisoryandtechnicaloccupationsAllpeople1 LowermanagerialandprofessionaloccupationsAllpeople1 LargeemployersandhighermanagerialoccupationsAllpeople1 IntermediateoccupationsAllpeople1 HigherprofessionaloccupationsAllpeople1 FulltimestudentAllpeople1 CharityandVoluntary1 Construction1 Environmental1 FinancialServices1 FoodandDrink1 Healthcare1 HigherEducationandResearch1 ICT1 LifeSciences1 CreativeIndustries1 Manufacturing1 MedicalEquipment1 Pharmaceuticals1 ProfessionalServices1 RealEstate1 Retail1 SocialWork1 TourismandLeisure1 TransportandLogistics1 Utilities1 IMD07Score RVperSqM_Offices RVperSqM_Retail_Premises RVperSqM_Factories RVperSqM_Warehouses LQFloorspaceOffices LQFloorspaceRetailPremises LQFloorspaceFactories LQFloorspaceWarehouses RatioEmpl_Workpl /PRINT UNIVARIATE INITIAL CORRELATION SIG KMO EXTRACTION ROTATION /FORMAT SORT /PLOT EIGEN ROTATION /CRITERIA MINEIGEN(1) ITERATE(250) /EXTRACTION PC /CRITERIA ITERATE(250) /ROTATION VARIMAX /SAVE REG(ALL) /METHOD=CORRELATION.

11.5 Introduction to MADM methodologies

11.5.1 Simple Multi-Attribute Rating Technique (SMART)

Simple Multi-Attribute Rating Technique (SMART) is based on the Multi-Attribute Utility Theory (MAUT), which relies on the use of utility functions to transform the raw performance values (scores) of each alternative against diverse criteria, recorded in different measurement scales including factual (objective, quantitative) and judgemental (subjective, qualitative) scales. These values associated with the criteria can then only properly reflect the relative importance of the criteria if the scores are transformed to a common, dimensionless scale. SMART allows the transformation of these incompatible scales to a common scale, in practice the intervals [0,1] or [0,100] are commonly used (Reyck et al. 2005).

Apart from this normalisation to a common scale, the utility functions also transform the raw scores so that a preferred score obtains a higher utility value . For example, if the goal is cost minimisation, the associated utility function will generate higher utility values for lower cost values. In the simplest case, these value functions are linear, but for more complex preference patterns, non-linear value functions can be used. The generation of the final ranking value for each alternative is obtained in the simple additive model by the weighted mean of the utility values. The outcome thus is not only dependant on the performance scores, but also on the weights attached to each criterion. Apart from the simple additive weighting method used in the original SMART approach, where the decision maker would directly assign the weights, more advanced weighting techniques are available:

- **Trade-off procedure** (Keeney & Raiffa 1976) makes use of direct assessments of trade-offs that a decision maker is willing to make. The method requires the decision maker to compare two alternatives (A and B) against two criteria (X and Y), and then assesses which alternative is preferred. Alternative A has the best score for criterion (X) and worst score for criterion (Y), while alternative B has the best score for the criterion (Y) and the worst for criterion (X). By picking the preferred alternative, and iterating for all combinations of criterions, relative weightings are generated for the most and least important criterions. A critical assumption underlying this method is that the trade-offs a decision maker is willing to make between two considered criteria (X,Y) do not depend on the levels of other criteria (University of Redlands and the SDS Consortium 2009).

- SMART with swing weights, shortened to **SMARTS** (Edwards & Barron 1994), is commonly used in decision-making. In this model, swing weights reflect both the range of difference between the least and most preferred options, and how much that difference matters to the decision maker. For example, in purchasing a car, one might consider its cost to be important in some absolute sense. However, if a shortlist of five cars only differs in price by £200, then price does not matter greatly to the decision. The price criterion would receive a low weight because the price difference is so small. On the other hand, if the price difference was £2,000, the criterion would likely receive more weight. In practice, swing weights are identified by comparing criteria two at a time for their preference swings (i.e. how much a change matters), always retaining the one with the bigger swing to be compared to a new criterion. The one criterion emerging from this process as showing the largest swing in preference is assigned a weight of 100, and any subsequently selected criteria are given a value relative percentage of the initial swing criterion. Raw weights are then normalised to come up with the final weights.

SMART's advantages are that the decision model is independent of the alternatives, the ranking of the alternatives is not relative, and the addition or subtraction of alternatives does not alter the decision scores of existing alternatives. However, the need for a large amount of quantitative data for the development of the value function does present a significant drawback to the method (Reyck et al. 2005). SMART and MAUT methodologies, in general, assume "transitivity"[61] of the preferences of decision makers, expressed in the utility functions, which cannot always be satisfied (Vargas 1989)[62].

11.5.2 Conjoint Analysis

Conjoint Analysis (CA) evolved from the seminal theoretical research of Luce & Tukey (1964), and is applied today mainly to market research for analysing consumer choice, and is also used in applied economics, sociology, transport, and medicine. CA today then "... *is a market researcher's favourite methodology for finding out how buyers make trade-offs among competing products and suppliers"* (Green et al. 2001, p.1). An in-depth review of the theoretical foundations and application issues can be found in Green & Srinivasan (1978) and

[61]Transitivity between preferences means that if A is preferred to B, and B is preferred to C, then A is preferred to C.

[62]Transitivity is not guaranteed, for example, in the Analytical Hierarchy Process (AHP), where scale intransitivity can occur. See section 0 for a more complete discussion of scale intransitivity.

more recently, Louviere et al. (2005). There are three common key stages in the design of a CA study, each attached to methodological choices:

1. Identify relevant choice attributes and levels to be analysed using the CA;
2. Develop a series of profiles and the definition of a model of preference to be applied to those hypothetical alternatives; and
3. Finally, evaluate and compute respondents' choices, arriving at the final outcome of the CA. In practice, the end goal of CA is to express the respondents' implicit numerical valuation for each attribute and level, generating a level utility function and importance score for each attribute of the considered product.

A widely used commercial conjoint model is Adaptive-Conjoint Analysis (ACA), first introduced by Johnson (Louviere et al. 2005), which presents pairs of partial profiles of hypothetical alternatives, constructed typically of levels on two, or perhaps three, attributes drawn from the full set of attributes. A respondent is asked to choose one alternative, and also state the graded preference intensity. Benefits of ACA include the ability to include a large number of attributes (up to 30) and levels (up to 7 per attribute). However, such a large number of attributes means that it is common for an ACA interview to last 45 minutes or more. In addition, care is needed in choosing and designing the attributes in order to get reliable utility values.

The most common alternative to ACA is Choice-based Conjoint (CBC) analysis. Whereas ACA requires users to select a product based on two or three attributes, CBC shows full descriptions, using all the attributes available. In addition, CBC shows more than just two "products" at the same time, enabling more realistic choice decisions. These "full-profile" combinations mean that choice-based conjoint analysis is typically limited to five to seven attributes (in contrast to 25-30 for ACA), in order not to overload respondents.

Common critiques of CA have focused on the lack of an underlying behavioral theory for CA, which would validate and guide the design of CA experiments, estimation of CA models, and results reporting. This has resulted in little agreement or consensus among academics and practitioners as to what constitutes CA best practice. This unresolved debate includes the determination of upper limits for the number of variables, levels, and observations for different implementations of CA (Louviere et al. 2005, p.57).

11.5.3 Analytical Hierarchy Process (AHP)

The third and final MCDM methodology evaluated during the course of this thesis is the Analytical Hierarchy Process (AHP), a method for prioritizing elemental issues in complex problems, originally developed by Saaty (1977). AHP has been successfully developed and applied over the past 30 years, in all aspects of Decision Science processes and applications: selection, evaluation, benefit–cost analysis, allocations, planning and development, priority and ranking, and decision-making (Vaidya & Kumar 2006).

AHP facilitates decision-making by breaking up the decision-making process into a series of pair-wise variable comparisons, based on the perceptions and judgments of the decision maker. A framework is constructed from these pair-wise comparisons, breaking down problems into a hierarchy of specific and quantifiable sub-problems. AHP allows the decision-making process to take advantage of the innate human capability to make sound judgments about small problems through pair-wise comparisons. The aggregated judgments in the decision hierarchy then provide the solution to more complex multi-attribute decisions. Pair-wise comparisons also have the added benefit of allowing the comparison and integration of quantitative and qualitative variables. Saaty claims that as a problem structuring method, AHP helps elicit the development of a decision framework through a process with the following six steps (Saaty 1990):

1. Define a problem structure that shows the problem’s key elements and their relationships. This includes the criteria as well as the alternatives considered.
2. Elicit judgments that reflect knowledge, feelings, or emotions from the user.
3. Assign meaningful numbers to those judgements.
4. Use these numbers to calculate the priorities of the elements of the hierarchy (see Figure 57 for the default priorities for a simple hierarchy).
5. Synthesize these results to determine overall outcome.
6. Analyse sensitivity to changes in judgment.

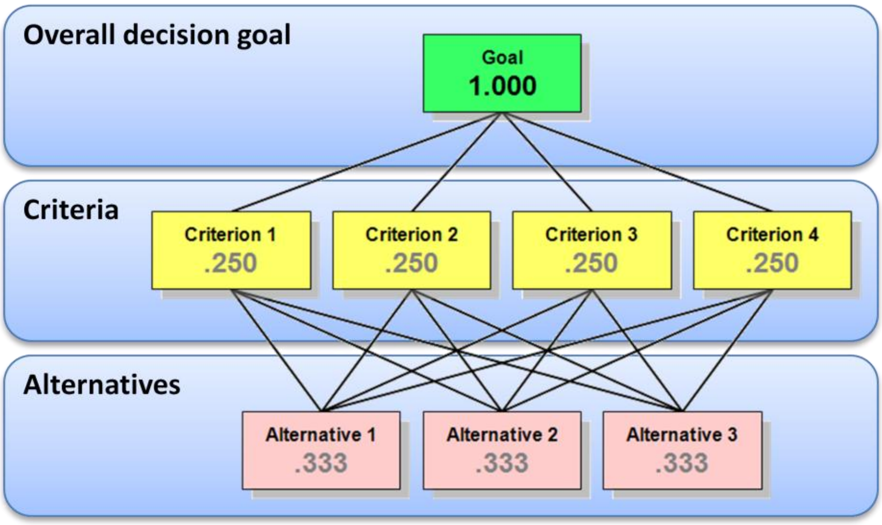


Figure 57: Example AHP hierarchy with default priorities attached[63].

In practical terms, the implementation of the AHP methodology involves the following key steps:

1. State the problem and develop a complete picture of all objectives, actors, and outcomes.

2. Identify key criteria that will influence the decision-making process, and classify these criteria into a tree-like hierarchical structure, progressing from general broad criteria down to specific and detailed criteria. (See Figure 57 for a simple example of such a decision tree, showing a simple, one-level criteria hierarchy). The number of levels in such a hierarchy will depend on the complexity of the problem and the degree of detail required for reaching a decision.

3. Elicit pair-wise comparisons from the decision maker at each hierarchical level for all the variables along a ratio scale, as detailed in Table 19.

4. Using the priorities derivation methodology, detailed in Appendix 11.5, generate the following values at each hierarchical level: Eigen Vector (normalised weights for each variable), Consistency Index CI, and Consistency Ratio CR[64]. Iterate for all levels of the

[63] Adapted from Saaty (1990)

[64] Saaty (1990) states that if the value of the Consistency Index CR (CI/RI) is equal to or less than the value of a equivalent Randon Consistency Index (RI) obtained from the generation of a randomly

decision hierarchy and aggregate the relative weights to come up with the overall weights for each criterion.

5. Monitor judgment inconsistencies (intransitivity) by checking that the Confidence Ratio is inside satisfactory limits. If this is not the case, revisit the pair-wise comparisons and rerun the process and check new results.

Table 19: The fundamental scale for pairwise comparisons[65]

Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one element over another
5	Strong importance	Experience and judgment strongly favour one element over another
7	Very strong importance	One element is favoured very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favouring one element over another is of the highest possible order of affirmation

Saaty's definition of AHP prescribes a specific scale for pair-wise comparisons. A specific verbal meaning is attached to five measurement levels when expressing preference over two variables, ranging from equal importance of the two variables, to moderate, strong, very strong and extreme importance/preferences for either of the two variables, as detailed in Table 18. The intensity values attached to each level are used as the input to develop the absolute final weights attributed to individual variables or decision hierarchies.

In the literature, discussion has often focused on specific differences between AHP and MAUT methodologies like SMART. MAUT adheres to the axioms of transitivity, whereas AHP has been criticised by MAUT proponents as introducing the rank reversal issue (Forman 1993). AHP thus implies the lack of "independence of irrelevant alternatives" (Donegan et al. 1992). In other words, the addition or removal of a "dummy alternative" to a set of genuine alternatives should not cause the rank of other alternatives to change. AHP allows for such

generated reciprocal matrix with the same scale, then the evaluation within the matrix is acceptable and indicates a good level of consistency in the comparative judgments.

[65] Adapted from Saaty (1990)

rank reversals to happen due to irrelevant or dominated alternatives. Rank reversal is argued by both Saaty (1990) and Forman (1993, p.20) to be a natural occurrence[66], occurring because of the abundance or dilution effect of supplemental alternatives. Value worth is more times than not affected by the relative abundance or scarcity, and thus the ability of a methodology to adjust rank in such cases is often a desired property (Forman & Gass 2001).

Concerning provisions in AHP for group decision-making, Saaty refers to the generation of an arithmetic mean of each participants' hierarchy, possibly weighted according to a separate expertise or influence ranking. Donegan et al. (1992), by contrast, argue that the geometric mean of a set of hierarchies as a way to find consensus amongst a panel of stakeholders cannot be a representative measure. Consensus among a group of hierarchies must be found by analysis of the final vectors, a much more difficult task.

11.5.3.1 AHP pair-wise comparisons matrix operations

A pairwise comparison matrix is called consistent if the transitivity (1) and the reciprocity (2) rules are respected, as well as if the pair-wise comparisons a_{ij} obey the equality (3) rule:

(1) $a_{ij} = a_{ik} * a_{kj}$

(2) $a_{ij} = \frac{1}{a_{ji}}$

(3) $a_{ij} = \frac{p_i}{p_j}$

with i, j, k *alternatives of the matrix and* p_i *the priority of alternative* i.

The pair-wise comparisons reciprocal matrix is in the form of (4):

(4) $A = \begin{bmatrix} {p_1}/{p_1} & \cdots & {p_1}/{p_n} \\ \vdots & \ddots & \vdots \\ {p_n}/{p_1} & \cdots & {p_n}/{p_n} \end{bmatrix}$

Saaty proposes the principal eigenvector $\vec{p}$ as the desired priorities vector. It is calculated with the following equation (5):

(5) $\boldsymbol{A}\,\vec{p} = \lambda_{max}\,\vec{p}$

[66] A famous example of a decision including rank reversal is the 2000 U.S. presidential election. Ralph Nader was an 'irrelevant' alternative, in that he was dominated by both the Democrat and Republican candidates. However, since he attracted more votes from those who would have voted Democrat rather than Republican, his presence caused the ranks to reverse. Put another way, if Nader were not in the race, it is widely accepted that Al Gore would have won.

With $\boldsymbol{A}$ the pair-wise comparisons matrix, $\vec{p}$ the priorities vector, λ_{max} the maximal eigenvalue.

11.5.3.2 Consistency measurement

Saaty proved that for a consistent reciprocal matrix, the largest eigenvalue is equal to the size of the comparison matrix $\lambda_{max} = n$. The inconsistency index (6) is a measure of the degree of inconsistency of a pair-wise comparisons matrix:

(6) $CI = \frac{\lambda_{max} - n}{n - 1}$

The consistency ratio (7) informs the user of the level of acceptable inconsistency, normally below 10%, with RI as given by Saaty's Random consistency Index table:

(7) $CR = \frac{CI}{RI}$

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

11.6 User testing Questionnaire results

For Think London Staff

Participant	Scenario 1	Scenario 2	Scenario 3	Do the Neighbourhood classes descriptions make sense and are they useful? If not, why not?	How relevant were they to your decision making? Did they provide enough information to make a decision?	Did you feel that the pair-wise comparisons a useful way to prioritise location variables?	Do you think that the results are relevant to problem, and do they make sense? Were you surprised about the results? Why?	Was there sufficient information in the output to enable you to understand and compare different neighbourhoods?	General comments
TL1	14:25 Concern about Mill Hill Sudbury Hill , focus on Ivory Towers alone	14:35 Surprised at West End coming top, presumed that it was more retail related	Hayes town first, issue of access to Heathrow overshadowing other variables	Yes Similarities between UP and BCF in terms of qualities Very similar name of Blue Collar Workers and Blue Chip Finance	Yes Helps get clearer view of location preferences and list of possible locations	Yes	Yes Most outputs made sense	Yes Property offer and cost missing Need to be able to drill down into individual variables constituting profiles Lists of other companies already there missing	Does Accessibility include airport express trains (i.e. Heathrow Express) Need to be able to turn outputs of tool into a form where it can be processed externally, put into report presented. Data export?
TL2	11:42 was PM of scenario origin project	11:48 Kings Cross needs to be included in accessibility analysis	Many location variables to consider in this case study	Yes Qualification levels of workforce useful Industry clusters	Yes Similarities between UP and BCF HS and SoL similar	Yes	Yes	Yes Top level information only Need more info on local accessibility, ie from TC to next tube station Property prices missing	Need to include industrial and commercial parks
TL3	11:21 cost was not included in tool, even though mentioned in scenario	11:41 more relevant results, question remains over priority of access vs tc char	11:50 found relevant after reducing accessibility	Yes expressed concern about cultural and linguistic misunderstandings and preconceptions of neighbourhood descriptions useful to understand client requirements makes explicit conceptions already formed in TL PM heads	Yes Sights of London was thought as difficult to understand and UP BCF difficult to distinguish Third Sector centres description was not attractive, refer to good value vs low value/quality office space	Yes Difference between moderate and strong too big, perception of linguistic difference vs numeric difference	Mixed Scenario 1 not reflective of reality, difficult and conflicting requirements, 2 and 3 more relevant	No Show weights of variables, Scale on radar charts, Need for descriptions of locations with pictures, supporting context and data Report of top 10, 5, 3 locations	Accessibility is given too much weight Tool is guiding investors too much to Central London locations Problem of neighbourhoods not including commercial/industrial parks, other areas between TC
TL4	14:35 Thought hayes town was a good choice "very accessible to both heathrow and central london" other choices not so appropriate difficult scenario with lots of conflicting variables	14:43 relevant results	hayes town came up again, accessibility important	Yes	Yes good starting point to get options need to investigate further afterwards	good to be able to compare and mix classes a bit arbitrary at times	Yes overall yes, first scenario not so much	need more information and context like pictures of neighbourhood, costs, commentary on how an area feels	
TL5	17:05 nee to include information on the extisting companies in areas	17:12	17:20 accessibility given too much weight	contradiction in terms of Blue Collar and Big sheds and trucks, position of Dagenham	cost component missing	weighting issue of accessiblity (linguistic significance of moderate and strong	could be confusing if you dont know about london and only go with recommendations	need to add customers, clients, competitors... In different areas ehtnic groups missing supplemented by informal knowledge	

For UCL Staff

Participant	Scenario 1	Scenario 2	Scenario 3	Do the Neighbourhood classes descriptions make sense and are they useful? If not, why not?	How relevant were they to your decision making? Did they provide enough information to make a decision?	Did you feel that the pair-wise comparisons a useful way to prioritise location variables?	Do you think that the results are relevant to problem, and do they make sense? Were you surprised about the results? Why?	Was there sufficient information in the output to enable you to understand and compare different neighbourhoods?	General comments
UCL1	16:05	16:16 ivory towers distracting skews ranking hayes town first, issue of accesssibility	16:29 ranking weights of accessibility (hayes town)	yes ivory towers skews ranking UP and BCF very similar	yes add example businesses to tc def	yes too many, access to direct methodology for doing absolute ranking small change large impact	yes need to iterate, but made sense hard to keep away from preconceived ideas	mixed show ranking score and generate groups (natural breaks) seach function for tc doesnt give info about absolute size and intensity of activities, number of businesses	sights of london most similar to original tc boundaries research
UCL2	14:59 rather not, surprised by results	15:20 finds edgware road highly appropriate	15:30 relevant results	Yes makes sense, acronyms to similar	Yes easy to understand some completely irrelevant to scenarios	Yes would like to see numbers , not slidebar and text need to visualise accessibility good way to express trade offs	Yes	Mixed need more data to support decision more stats of general size of TC should only give most relevant TC as options in output, not complete list	finds scale of AHP too extreme
UCL3	11:05 didnt find options suitable went back to change preferences hayes town and uxbridge he found suitable	11:15 found results suitable, picked west end	11:30 west end again, question of price over edgeware road	yes yes, but then it was the only information on which to go on	yes difficult to capture everything in title, sometimes like in Sights of London doesnt work titles important but can introduce biais BC BCF too similar titles	yes wanted to be able to directly rank importance, but pair wise comparisons give more control need to tell user when he has made a choice	yes first scenario less clear, but later ones relevant	yes overview map needed	quick easy to use
UCL4	14:38 ivory towers overpowers other variables	14:46 hayes town first	14:50	yes	yes bored of number of choices	yes makes you think about scenario	yes useful to be able to see impact	yes need side-by-side comparison of multiple TC show actual numbers in radar chart	
UCL5	15:36 Sudbury Hill first thought other west london locations would be more appropriate	15:48 city & west end first	hayes town first even though accessibility only 25%	yes some were quite similar UP BCF 9 classes too many	yes more specific information on workers in software services for example where is the competition	yes number of choices gets confusing, need indicator of choices already made potential contradiction between choices does order of choices make difference in answer	yes	yes neighbourhood boundaries help show distribution of components across whole of London, ie strengths of regions for specific components	

11.7 T-test statistics of Confidence Ratio

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Scenario_1	UCL	5	.1440	.08019	.03586
	TL	5	.0780	.03347	.01497
Scenario_2	UCL	5	.1320	.05891	.02634
	TL	5	.1220	.05450	.02437
Scenario_3	UCL	5	.1420	.07396	.03308
	TL	5	.1200	.04416	.01975

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Scenario_1	Equal variances assumed	1.588	.243	1.698	8	.128	.06600	.03886	-.02361	.15561
	Equal variances not assumed			1.698	5.352	.146	.06600	.03886	-.03194	.16394
Scenario_2	Equal variances assumed	.266	.620	.279	8	.788	.01000	.03589	-.07276	.09276
	Equal variances not assumed			.279	7.952	.788	.01000	.03589	-.07285	.09285
Scenario_3	Equal variances assumed	3.736	.089	.571	8	.584	.02200	.03852	-.06683	.11083
	Equal variances not assumed			.571	6.530	.587	.02200	.03852	-.07044	.11444

11.8 T-test statistics for geo-business variable weights

11.8.1 Scenario 1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
UP	10	.0235	.3478	.098262	.1072420	.012	1.847	.687	2.737	1.334
BC	10	.0136	.3580	.168964	.1055491	.011	.271	.687	-.516	1.334
BCF	10	.0194	.1609	.063033	.0468232	.002	1.053	.687	.498	1.334
TS	10	.0166	.1767	.075524	.0499077	.002	.970	.687	.446	1.334
BS	10	.0656	.3117	.194518	.0840896	.007	-.140	.687	-1.442	1.334
HES	10	.0152	.1013	.048990	.0260815	.001	.665	.687	.368	1.334
CGM	10	.0270	.1114	.061079	.0275496	.001	.810	.687	-.104	1.334
SoF	10	.0191	.1125	.054991	.0323010	.001	.741	.687	-.467	1.334
IT	10	.0949	.3518	.234638	.0969164	.009	-.312	.687	-1.536	1.334
Valid N	10									

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
UP	UCL	5	.084979	.0847229	.0378892
	TL	5	.111545	.1351216	.0604282
BC	UCL	5	.166831	.1321768	.0591113
	TL	5	.171098	.0870877	.0389468
BCF	UCL	5	.048982	.0374661	.0167554
	TL	5	.077084	.0550968	.0246400
TS	UCL	5	.069010	.0647122	.0289402
	TL	5	.082039	.0362005	.0161893
BS	UCL	5	.202262	.0891562	.0398719
	TL	5	.186774	.0883805	.0395249
HES	UCL	5	.047852	.0343139	.0153456
	TL	5	.050128	.0187049	.0083651

CGM	UCL	5	.072498	.0317235	.0141872
	TL	5	.049660	.0193733	.0086640
SoF	UCL	5	.059655	.0446559	.0199707
	TL	5	.050327	.0172924	.0077334
IT	UCL	5	.247931	.1136745	.0508368
	TL	5	.221344	.0881483	.0394211

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
UP	Equal variances assumed	.644	.445	-.372	8	.719	-.0265661	.0713244	-.1910403	.1379082
	Equal variances not assumed			-.372	6.724	.721	-.0265661	.0713244	-.1966343	.1435022
BC	Equal variances assumed	.451	.521	-.060	8	.953	-.0042674	.0707884	-.1675057	.1589709
	Equal variances not assumed			-.060	6.922	.954	-.0042674	.0707884	-.1720375	.1635026
BCF	Equal variances assumed	.749	.412	-.943	8	.373	-.0281015	.0297972	-.0968140	.0406110
	Equal variances not assumed			-.943	7.048	.377	-.0281015	.0297972	-.0984643	.0422613
TS	Equal variances assumed	1.121	.321	-.393	8	.705	-.0130297	.0331607	-.0894983	.0634390
	Equal variances not assumed			-.393	6.280	.707	-.0130297	.0331607	-.0933014	.0672421
BS	Equal variances assumed	.017	.900	.276	8	.790	.0154883	.0561426	-.1139767	.1449533

	Equal variances not assumed			.276	7.999	.790	.0154883	.0561426	-.1139784	.1449550
HES	Equal variances assumed	.808	.395	-.130	8	.900	-.0022766	.0174775	-.0425797	.0380266
	Equal variances not assumed			-.130	6.184	.900	-.0022766	.0174775	-.0447354	.0401822
CGM	Equal variances assumed	4.057	.079	1.374	8	.207	.0228387	.0166235	-.0154952	.0611725
	Equal variances not assumed			1.374	6.619	.214	.0228387	.0166235	-.0169327	.0626100
SoF	Equal variances assumed	10.629	.012	.436	8	.675	.0093276	.0214158	-.0400573	.0587124
	Equal variances not assumed			.436	5.173	.681	.0093276	.0214158	-.0451735	.0638286
IT	Equal variances assumed	1.465	.261	.413	8	.690	.0265867	.0643304	-.1217595	.1749329
	Equal variances not assumed			.413	7.533	.691	.0265867	.0643304	-.1233755	.1765488

11.8.2 Scenario 2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
UP	10	.1294	.3529	.260273	.0728698	.005	-.544	.687	-.610	1.334
BC	10	.0144	.1364	.037845	.0351260	.001	2.987	.687	9.230	1.334
BCF	10	.0913	.4014	.293589	.0901401	.008	-1.101	.687	2.080	1.334
TS	10	.0136	.1071	.033263	.0265075	.001	2.910	.687	8.898	1.334
BS	10	.0163	.0559	.025669	.0120793	.000	1.959	.687	4.500	1.334
HES	10	.0221	.1443	.056380	.0405226	.002	1.583	.687	1.547	1.334
CGM	10	.0275	.3301	.105622	.0930310	.009	1.669	.687	3.481	1.334
SoF	10	.0242	.2346	.113822	.0773022	.006	.328	.687	-1.446	1.334
IT	10	.0355	.1338	.073537	.0386765	.001	.694	.687	-1.373	1.334
Valid N	10									

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
UP	UCL	5	.235130	.0766741	.0342897
	TL	5	.285416	.0669940	.0299606
BC	UCL	5	.024724	.0077165	.0034509
	TL	5	.050966	.0478142	.0213831
BCF	UCL	5	.257705	.1112285	.0497429
	TL	5	.329473	.0518733	.0231984
TS	UCL	5	.040691	.0377037	.0168616
	TL	5	.025835	.0046330	.0020719
BS	UCL	5	.029669	.0155307	.0069456
	TL	5	.021669	.0068620	.0030688
HES	UCL	5	.054000	.0366923	.0164093
	TL	5	.058761	.0483135	.0216065
CGM	UCL	5	.142929	.1140726	.0510148
	TL	5	.068315	.0545999	.0244178

SoF	UCL	5	.137437	.0926564	.0414372
	TL	5	.090208	.0588715	.0263281
IT	UCL	5	.077716	.0426155	.0190582
	TL	5	.069358	.0388067	.0173549

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
UP	Equal variances assumed	.279	.612	-1.104	8	.302	-.0502856	.0455349	-.1552892	.0547179
	Equal variances not assumed			-1.104	7.859	.302	-.0502856	.0455349	-.1556190	.0550477
BC	Equal variances assumed	4.698	.062	-1.212	8	.260	-.0262418	.0216598	-.0761894	.0237058
	Equal variances not assumed			-1.212	4.208	.289	-.0262418	.0216598	-.0852236	.0327399
BCF	Equal variances assumed	.822	.391	-1.308	8	.227	-.0717683	.0548865	-.1983367	.0548001
	Equal variances not assumed			-1.308	5.661	.242	-.0717683	.0548865	-.2080420	.0645054
TS	Equal variances assumed	4.806	.060	.874	8	.407	.0148555	.0169884	-.0243199	.0540309
	Equal variances not assumed			.874	4.121	.430	.0148555	.0169884	-.0317717	.0614827
BS	Equal variances assumed	1.374	.275	1.054	8	.323	.0080004	.0075933	-.0095098	.0255105
	Equal variances not assumed			1.054	5.504	.336	.0080004	.0075933	-.0109929	.0269936

HES	Equal variances assumed	.147	.712	-.175	8	.865	-.0047612	.0271312	-.0673259	.0578036
	Equal variances not assumed			-.175	7.462	.865	-.0047612	.0271312	-.0681192	.0585969
CGM	Equal variances assumed	1.109	.323	1.319	8	.224	.0746136	.0565574	-.0558080	.2050353
	Equal variances not assumed			1.319	5.741	.237	.0746136	.0565574	-.0653026	.2145299
SoF	Equal variances assumed	1.967	.198	.962	8	.364	.0472289	.0490939	-.0659819	.1604397
	Equal variances not assumed			.962	6.777	.369	.0472289	.0490939	-.0696386	.1640964
IT	Equal variances assumed	.265	.621	.324	8	.754	.0083586	.0257761	-.0510812	.0677984
	Equal variances not assumed			.324	7.931	.754	.0083586	.0257761	-.0511714	.0678887

11.8.3 Scenario 3

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
UP	10	.0749	.3874	.184742	.0973485	.009	1.161	.687	.904	1.334
BC	10	.0136	.0999	.040607	.0304200	.001	.938	.687	-.317	1.334
BCF	10	.0621	.1483	.109470	.0279829	.001	.108	.687	-.587	1.334
TS	10	.0146	.0909	.044956	.0244105	.001	.771	.687	-.289	1.334
BS	10	.0144	.0995	.035209	.0242171	.001	2.395	.687	6.725	1.334
HES	10	.0262	.1061	.066510	.0295322	.001	.151	.687	-1.597	1.334
CGM	10	.1571	.5068	.354761	.1371870	.019	-.492	.687	-1.696	1.334
SoF	10	.0310	.1015	.064256	.0308174	.001	.193	.687	-2.184	1.334
IT	10	.0238	.2252	.099488	.0546928	.003	1.311	.687	2.746	1.334
Valid N	10									

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
UP	UCL	5	.166242	.0932735	.0417132
	TL	5	.203241	.1084763	.0485121
BC	UCL	5	.044970	.0269051	.0120323
	TL	5	.036245	.0362028	.0161904
BCF	UCL	5	.098554	.0083124	.0037174
	TL	5	.120386	.0373476	.0167023
TS	UCL	5	.046943	.0240694	.0107642
	TL	5	.042969	.0274137	.0122598
BS	UCL	5	.043322	.0317070	.0141798
	TL	5	.027097	.0122341	.0054713
HES	UCL	5	.069530	.0366805	.0164040
	TL	5	.063491	.0243740	.0109004
CGM	UCL	5	.354733	.1398817	.0625570
	TL	5	.354789	.1509261	.0674962

SoF	UCL	5	.069183	.0318586	.0142476
	TL	5	.059330	.0325761	.0145685
IT	UCL	5	.106524	.0735086	.0328741
	TL	5	.092451	.0346862	.0155122

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
UP	Equal variances assumed	.000	.996	-.578	8	.579	-.0369991	.0639798	-.1845367	.1105385
	Equal variances not assumed			-.578	7.824	.579	-.0369991	.0639798	-.1851155	.1111173
BC	Equal variances assumed	.070	.798	.433	8	.677	.0087246	.0201719	-.0377919	.0552411
	Equal variances not assumed			.433	7.386	.678	.0087246	.0201719	-.0384740	.0559232
BCF	Equal variances assumed	10.112	.013	-1.276	8	.238	-.0218326	.0171110	-.0612907	.0176255
	Equal variances not assumed			-1.276	4.395	.265	-.0218326	.0171110	-.0677018	.0240366
TS	Equal variances assumed	.000	.990	.244	8	.814	.0039739	.0163147	-.0336478	.0415957
	Equal variances not assumed			.244	7.868	.814	.0039739	.0163147	-.0337577	.0417056
BS	Equal variances assumed	1.914	.204	1.068	8	.317	.0162254	.0151988	-.0188230	.0512737
	Equal variances not assumed			1.068	5.165	.333	.0162254	.0151988	-.0224714	.0549221

HES	Equal variances assumed	2.449	.156	.307	8	.767	.0060386	.0196954	-.0393791	.0514564
	Equal variances not assumed			.307	6.956	.768	.0060386	.0196954	-.0405933	.0526706
CGM	Equal variances assumed	.396	.547	.000	8	1.000	-.0000563	.0920278	-.2122728	.2121602
	Equal variances not assumed			.000	7.954	1.000	-.0000563	.0920278	-.2124855	.2123729
SoF	Equal variances assumed	.132	.726	.484	8	.642	.0098528	.0203773	-.0371374	.0568429
	Equal variances not assumed			.484	7.996	.642	.0098528	.0203773	-.0371414	.0568470
IT	Equal variances assumed	.671	.437	.387	8	.709	.0140727	.0363501	-.0697508	.0978962
	Equal variances not assumed			.387	5.697	.713	.0140727	.0363501	-.0760317	.1041771

11.9 T-test statistics for location recommendations

11.9.1 Scenario 1

Independent Samples Test

	Equal variance	Levene's Test for Equality of Variances F	Levene's Test for Equality of Variances Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
Barnet	assumed	0.09	0.78	-0.21	8.00	0.84	-0.01	0.05	-0.11	0.10
	not ass.			-0.21	7.97	0.84	-0.01	0.05	-0.11	0.10
Enfield	assumed	0.38	0.55	-0.27	8.00	0.79	-0.01	0.05	-0.12	0.10
	not ass.			-0.27	7.74	0.79	-0.01	0.05	-0.12	0.10
New Barnet	assumed	0.22	0.65	-0.23	8.00	0.83	-0.01	0.05	-0.13	0.10
	not ass.			-0.23	7.79	0.83	-0.01	0.05	-0.13	0.10
Chingford	assumed	0.09	0.77	-0.16	8.00	0.87	-0.01	0.04	-0.09	0.08
	not ass.			-0.16	7.97	0.87	-0.01	0.04	-0.09	0.08
Southgate	assumed	0.42	0.53	-0.17	8.00	0.87	-0.01	0.05	-0.13	0.11
	not ass.			-0.17	7.67	0.87	-0.01	0.05	-0.13	0.11
Winchmore Hill	assumed	0.27	0.62	-0.24	8.00	0.82	-0.01	0.05	-0.12	0.09
	not ass.			-0.24	7.80	0.82	-0.01	0.05	-0.12	0.09
Whetstone	assumed	0.23	0.64	-0.28	8.00	0.79	-0.02	0.06	-0.15	0.12
	not ass.			-0.28	7.85	0.79	-0.02	0.06	-0.15	0.12
Lower Edmonton	assumed	0.05	0.82	-0.43	8.00	0.68	-0.01	0.03	-0.08	0.06
	not ass.			-0.43	7.90	0.68	-0.01	0.03	-0.08	0.06
Chingford Mount	assumed	0.01	0.95	-0.09	8.00	0.93	0.00	0.03	-0.07	0.06
	not ass.			-0.09	7.92	0.93	0.00	0.03	-0.07	0.06
Palmers Green	assumed	0.13	0.72	-0.20	8.00	0.84	-0.01	0.04	-0.10	0.09
	not ass.			-0.20	7.94	0.84	-0.01	0.04	-0.10	0.09
Stanmore	assumed	0.22	0.65	-0.37	8.00	0.72	-0.02	0.06	-0.15	0.11
	not ass.			-0.37	7.92	0.72	-0.02	0.06	-0.15	0.11
Upper Edmonton	assumed	0.01	0.92	-0.40	8.00	0.70	-0.02	0.04	-0.11	0.08
	not ass.			-0.40	7.98	0.70	-0.02	0.04	-0.11	0.08
Mill Hill	assumed	1.91	0.20	0.49	8.00	0.64	0.02	0.04	-0.08	0.12
	not ass.			0.49	5.87	0.64	0.02	0.04	-0.08	0.12
North Finchley	assumed	0.27	0.62	-0.22	8.00	0.83	-0.01	0.05	-0.13	0.11
	not ass.			-0.22	7.87	0.83	-0.01	0.05	-0.14	0.11
Northwood	assumed	0.08	0.79	-0.19	8.00	0.85	-0.01	0.04	-0.11	0.09

	not ass.			-0.19	7.95	0.85	-0.01	0.04	-0.11	0.09
Edgware	assumed	0.22	0.65	-0.28	8.00	0.79	-0.01	0.05	-0.12	0.10
	not ass.			-0.28	7.86	0.79	-0.01	0.05	-0.12	0.10
North Tottenham	assumed	0.32	0.59	-0.44	8.00	0.67	-0.02	0.04	-0.11	0.07
	not ass.			-0.44	7.66	0.67	-0.02	0.04	-0.11	0.07
Burnt Oak	assumed	0.19	0.67	-0.29	8.00	0.78	-0.01	0.04	-0.10	0.08
	not ass.			-0.29	7.84	0.78	-0.01	0.04	-0.10	0.08
Finchley	assumed	0.33	0.58	-0.21	8.00	0.84	-0.01	0.06	-0.14	0.12
	not ass.			-0.21	7.82	0.84	-0.01	0.06	-0.15	0.12
South Woodford	assumed	0.07	0.80	-0.09	8.00	0.93	0.00	0.03	-0.08	0.08
	not ass.			-0.09	7.99	0.93	0.00	0.03	-0.08	0.08
Tottenham	assumed	0.04	0.85	-0.50	8.00	0.63	-0.02	0.04	-0.13	0.08
	not ass.			-0.50	7.95	0.63	-0.02	0.04	-0.13	0.08
Barkingside	assumed	0.20	0.67	-0.21	8.00	0.84	-0.01	0.04	-0.09	0.08
	not ass.			-0.21	7.94	0.84	-0.01	0.04	-0.09	0.08
Wood Green	assumed	0.05	0.84	-0.23	8.00	0.82	-0.01	0.04	-0.10	0.08
	not ass.			-0.23	8.00	0.82	-0.01	0.04	-0.10	0.08
Wealdstone	assumed	0.12	0.73	-0.27	8.00	0.79	-0.01	0.05	-0.12	0.09
	not ass.			-0.27	7.75	0.79	-0.01	0.05	-0.12	0.09
Pinner	assumed	0.35	0.57	-0.10	8.00	0.93	0.00	0.05	-0.12	0.11
	not ass.			-0.10	7.86	0.93	0.00	0.05	-0.12	0.11
Muswell Hill	assumed	0.05	0.83	-0.06	8.00	0.95	0.00	0.05	-0.11	0.10
	not ass.			-0.06	8.00	0.95	0.00	0.05	-0.11	0.10
East Finchley	assumed	0.11	0.75	-0.16	8.00	0.87	-0.01	0.05	-0.12	0.10
	not ass.			-0.16	7.94	0.87	-0.01	0.05	-0.12	0.10
Brent Street	assumed	0.16	0.70	-0.26	8.00	0.80	-0.01	0.05	-0.14	0.11
	not ass.			-0.26	7.96	0.80	-0.01	0.05	-0.14	0.11
Kingsbury	assumed	0.17	0.69	-0.03	8.00	0.98	0.00	0.04	-0.09	0.09
	not ass.			-0.03	7.90	0.98	0.00	0.04	-0.09	0.09
Walthamstow	assumed	0.05	0.83	-0.27	8.00	0.80	-0.01	0.04	-0.10	0.08
	not ass.			-0.27	8.00	0.80	-0.01	0.04	-0.10	0.08
North Harrow	assumed	0.16	0.70	-0.13	8.00	0.90	-0.01	0.04	-0.11	0.10
	not ass.			-0.13	7.86	0.90	-0.01	0.04	-0.11	0.10
Hendon Central	assumed	0.11	0.74	0.08	8.00	0.93	0.00	0.03	-0.07	0.08
	not ass.			0.08	7.96	0.93	0.00	0.03	-0.07	0.08
Kenton	assumed	1.27	0.29	-0.26	8.00	0.80	-0.01	0.05	-0.12	0.09
	not ass.			-0.26	7.30	0.80	-0.01	0.05	-0.12	0.10
Temple Fortune	assumed	0.07	0.80	-0.12	8.00	0.90	-0.01	0.05	-0.11	0.10
	not ass.			-0.12	8.00	0.90	-0.01	0.05	-0.11	0.10

Romford	assumed	0.17	0.69	-0.27	8.00	0.79	-0.01	0.04	-0.11	0.08
	not ass.			-0.27	7.97	0.79	-0.01	0.04	-0.11	0.08
Gants Hill	assumed	0.20	0.66	-0.32	8.00	0.76	-0.02	0.05	-0.13	0.10
	not ass.			-0.32	7.67	0.76	-0.02	0.05	-0.13	0.10
Crouch End	assumed	0.07	0.80	-0.10	8.00	0.92	0.00	0.04	-0.11	0.10
	not ass.			-0.10	7.95	0.92	0.00	0.04	-0.11	0.10
Green Lanes	assumed	0.01	0.94	-0.26	8.00	0.80	-0.01	0.03	-0.09	0.07
	not ass.			-0.26	8.00	0.80	-0.01	0.03	-0.09	0.07
Bakers Arms	assumed	0.08	0.79	-0.39	8.00	0.71	-0.02	0.04	-0.11	0.08
	not ass.			-0.39	7.88	0.71	-0.02	0.04	-0.11	0.08
Chadwell Heath	assumed	0.03	0.86	-0.27	8.00	0.80	-0.01	0.03	-0.09	0.07
	not ass.			-0.27	8.00	0.80	-0.01	0.03	-0.09	0.07
Harrow	assumed	0.35	0.57	-0.24	8.00	0.82	-0.01	0.05	-0.13	0.11
	not ass.			-0.24	7.80	0.82	-0.01	0.05	-0.13	0.11
Brent Cross	assumed	0.13	0.73	0.35	8.00	0.73	0.01	0.03	-0.05	0.07
	not ass.			0.35	7.55	0.73	0.01	0.03	-0.05	0.07
Stamford Hill	assumed	0.04	0.86	-0.36	8.00	0.73	-0.02	0.05	-0.12	0.09
	not ass.			-0.36	8.00	0.73	-0.02	0.05	-0.12	0.09
Eastcote	assumed	0.28	0.61	-0.06	8.00	0.96	0.00	0.05	-0.12	0.11
	not ass.			-0.06	7.69	0.96	0.00	0.05	-0.12	0.11
Rayners Lane	assumed	0.15	0.71	-0.16	8.00	0.88	-0.01	0.05	-0.11	0.10
	not ass.			-0.16	7.92	0.88	-0.01	0.05	-0.11	0.10
Highgate	assumed	0.11	0.74	0.03	8.00	0.98	0.00	0.05	-0.11	0.12
	not ass.			0.03	7.92	0.98	0.00	0.05	-0.11	0.12
Leytonstone	assumed	0.06	0.82	-0.29	8.00	0.78	-0.01	0.04	-0.09	0.07
	not ass.			-0.29	7.98	0.78	-0.01	0.04	-0.09	0.07
Golders Green	assumed	0.10	0.76	-0.19	8.00	0.85	-0.01	0.05	-0.12	0.10
	not ass.			-0.19	7.97	0.85	-0.01	0.05	-0.12	0.10
Seven Kings	assumed	0.20	0.67	-0.35	8.00	0.73	-0.02	0.05	-0.12	0.09
	not ass.			-0.35	7.93	0.73	-0.02	0.05	-0.12	0.09
Ruislip	assumed	0.06	0.82	0.15	8.00	0.89	0.01	0.04	-0.08	0.09
	not ass.			0.15	7.98	0.89	0.01	0.04	-0.08	0.09
Ruislip Manor	assumed	0.09	0.77	-0.13	8.00	0.90	-0.01	0.04	-0.09	0.08
	not ass.			-0.13	7.79	0.90	-0.01	0.04	-0.09	0.08
Hornchurch	assumed	0.03	0.86	-0.03	8.00	0.98	0.00	0.03	-0.08	0.07
	not ass.			-0.03	7.99	0.98	0.00	0.03	-0.08	0.07
Archway	assumed	0.28	0.61	-0.40	8.00	0.70	-0.02	0.06	-0.16	0.11
	not ass.			-0.40	7.70	0.70	-0.02	0.06	-0.16	0.11
Finsbury Park	assumed	0.06	0.81	-0.24	8.00	0.82	-0.01	0.04	-0.09	0.08

	not ass.			-0.24	8.00	0.82	-0.01	0.04	-0.09	0.08
Upminster	assumed	0.05	0.83	-0.05	8.00	0.96	0.00	0.03	-0.08	0.08
	not ass.			-0.05	7.92	0.96	0.00	0.03	-0.08	0.08
South Harrow	assumed	0.51	0.50	-0.11	8.00	0.91	-0.01	0.05	-0.13	0.11
	not ass.			-0.11	7.45	0.91	-0.01	0.05	-0.13	0.12
Ilford	assumed	0.35	0.57	-0.31	8.00	0.76	-0.01	0.04	-0.12	0.09
	not ass.			-0.31	7.80	0.76	-0.01	0.04	-0.12	0.09
Stoke Newington	assumed	0.04	0.84	-0.27	8.00	0.79	-0.01	0.04	-0.11	0.09
	not ass.			-0.27	8.00	0.79	-0.01	0.04	-0.11	0.09
Wembley Park	assumed	0.05	0.82	-0.27	8.00	0.80	-0.01	0.04	-0.10	0.08
	not ass.			-0.27	7.87	0.80	-0.01	0.04	-0.10	0.08
Holloway Road	assumed	0.15	0.70	-0.25	8.00	0.81	-0.01	0.04	-0.10	0.08
	not ass.			-0.25	8.00	0.81	-0.01	0.04	-0.10	0.08
Hampstead	assumed	0.01	0.93	-0.14	8.00	0.89	-0.01	0.06	-0.14	0.12
	not ass.			-0.14	8.00	0.89	-0.01	0.06	-0.14	0.12
Cricklewood	assumed	0.08	0.78	-0.17	8.00	0.87	-0.01	0.05	-0.11	0.10
	not ass.			-0.17	7.97	0.87	-0.01	0.05	-0.11	0.10
Highgate Road	assumed	0.15	0.71	-0.12	8.00	0.91	-0.01	0.05	-0.13	0.12
	not ass.			-0.12	7.73	0.91	-0.01	0.05	-0.13	0.12
Sudbury Hill	assumed	0.33	0.58	0.80	8.00	0.45	0.02	0.02	-0.04	0.08
	not ass.			0.80	7.94	0.45	0.02	0.02	-0.04	0.08
Haverstock Hill	assumed	0.00	0.97	-0.14	8.00	0.89	-0.01	0.05	-0.13	0.12
	not ass.			-0.14	7.99	0.89	-0.01	0.05	-0.13	0.12
Wembley	assumed	0.13	0.73	-0.31	8.00	0.77	-0.01	0.05	-0.12	0.09
	not ass.			-0.31	7.81	0.77	-0.01	0.05	-0.12	0.09
Forest Gate	assumed	0.01	0.91	-0.39	8.00	0.71	-0.02	0.04	-0.11	0.08
	not ass.			-0.39	7.97	0.71	-0.02	0.04	-0.11	0.08
Willesden Green	assumed	0.04	0.84	-0.31	8.00	0.77	-0.01	0.04	-0.11	0.08
	not ass.			-0.31	7.97	0.77	-0.01	0.04	-0.11	0.08
Brondesbury Park	assumed	0.12	0.74	-0.22	8.00	0.83	-0.01	0.04	-0.11	0.09
	not ass.			-0.22	7.90	0.83	-0.01	0.04	-0.11	0.09
Dalston	assumed	0.07	0.80	-0.20	8.00	0.85	-0.01	0.05	-0.13	0.11
	not ass.			-0.20	7.98	0.85	-0.01	0.05	-0.13	0.11
West Hampstead	assumed	0.13	0.73	-0.03	8.00	0.98	0.00	0.05	-0.11	0.11
	not ass.			-0.03	7.96	0.98	0.00	0.05	-0.11	0.11
England's Lane	assumed	0.00	0.95	0.01	8.00	0.99	0.00	0.05	-0.10	0.10
	not ass.			0.01	8.00	0.99	0.00	0.05	-0.10	0.10
Hackney	assumed	0.08	0.78	-0.37	8.00	0.72	-0.02	0.04	-0.12	0.09
	not ass.			-0.37	7.91	0.72	-0.02	0.04	-0.12	0.09

Dagenham	assumed	6.69	0.03	-0.29	8.00	0.78	-0.02	0.06	-0.15	0.11
	not ass.			-0.29	5.58	0.78	-0.02	0.06	-0.16	0.12
Kentish Town	assumed	0.18	0.69	0.01	8.00	0.99	0.00	0.05	-0.12	0.12
	not ass.			0.01	7.89	0.99	0.00	0.05	-0.12	0.12
Finchley Road,Swiss Cottage	assumed	0.18	0.69	-0.08	8.00	0.94	0.00	0.05	-0.13	0.12
	not ass.			-0.08	7.92	0.94	0.00	0.05	-0.13	0.12
Stratford	assumed	0.12	0.74	-0.40	8.00	0.70	-0.02	0.05	-0.13	0.09
	not ass.			-0.40	7.89	0.70	-0.02	0.05	-0.13	0.09
Caledonian Road	assumed	0.16	0.70	-0.17	8.00	0.87	-0.01	0.05	-0.13	0.11
	not ass.			-0.17	7.82	0.87	-0.01	0.05	-0.13	0.11
Barking	assumed	0.24	0.64	-0.43	8.00	0.68	-0.02	0.05	-0.12	0.09
	not ass.			-0.43	7.84	0.68	-0.02	0.05	-0.13	0.09
Uxbridge	assumed	0.25	0.63	-0.19	8.00	0.85	-0.01	0.05	-0.12	0.10
	not ass.			-0.19	7.76	0.85	-0.01	0.05	-0.12	0.10
Upton Park	assumed	0.00	0.98	-0.26	8.00	0.80	-0.01	0.03	-0.09	0.07
	not ass.			-0.26	7.98	0.80	-0.01	0.03	-0.09	0.07
Kilburn	assumed	0.12	0.74	-0.09	8.00	0.93	0.00	0.05	-0.11	0.10
	not ass.			-0.09	7.95	0.93	0.00	0.05	-0.11	0.10
East Ham	assumed	0.23	0.64	-0.34	8.00	0.74	-0.01	0.04	-0.11	0.08
	not ass.			-0.34	7.93	0.74	-0.01	0.04	-0.11	0.09
Kensal Rise	assumed	0.24	0.64	0.07	8.00	0.94	0.00	0.05	-0.11	0.12
	not ass.			0.07	7.78	0.94	0.00	0.05	-0.11	0.12
Bow	assumed	0.61	0.46	-0.45	8.00	0.66	-0.02	0.04	-0.11	0.07
	not ass.			-0.45	7.61	0.66	-0.02	0.04	-0.11	0.07
Harlesden	assumed	0.05	0.84	-0.16	8.00	0.88	-0.01	0.04	-0.09	0.08
	not ass.			-0.16	7.99	0.88	-0.01	0.04	-0.09	0.08
Camden Town	assumed	0.30	0.60	-0.05	8.00	0.96	0.00	0.06	-0.14	0.13
	not ass.			-0.05	7.79	0.96	0.00	0.06	-0.14	0.13
St Johns Wood	assumed	0.11	0.75	-0.23	8.00	0.83	-0.01	0.06	-0.15	0.12
	not ass.			-0.23	7.93	0.83	-0.01	0.06	-0.15	0.12
Bethnal Green	assumed	0.12	0.74	-0.27	8.00	0.79	-0.01	0.04	-0.10	0.08
	not ass.			-0.27	7.95	0.79	-0.01	0.04	-0.10	0.08
Maida Vale	assumed	0.09	0.78	-0.13	8.00	0.90	-0.01	0.05	-0.13	0.11
	not ass.			-0.13	7.97	0.90	-0.01	0.05	-0.13	0.11
Kensal Town	assumed	0.04	0.84	-0.15	8.00	0.89	-0.01	0.05	-0.12	0.11
	not ass.			-0.15	7.99	0.89	-0.01	0.05	-0.12	0.11
Greenford	assumed	0.11	0.75	-0.14	8.00	0.89	-0.01	0.04	-0.09	0.08
	not ass.			-0.14	7.85	0.89	-0.01	0.04	-0.09	0.08
Maida Hill	assumed	0.08	0.79	-0.24	8.00	0.81	-0.01	0.05	-0.13	0.10

	not ass.			-0.24	7.95	0.81	-0.01	0.05	-0.13	0.10
Mile End Road	assumed	0.41	0.54	-0.36	8.00	0.73	-0.02	0.06	-0.16	0.12
	not ass.			-0.36	7.64	0.73	-0.02	0.06	-0.16	0.12
North Kensington	assumed	0.04	0.84	-0.12	8.00	0.91	-0.01	0.05	-0.12	0.11
	not ass.			-0.12	8.00	0.91	-0.01	0.05	-0.12	0.11
Limehouse	assumed	0.32	0.59	-0.38	8.00	0.72	-0.02	0.05	-0.13	0.09
	not ass.			-0.38	7.71	0.72	-0.02	0.05	-0.13	0.09
Yiewsley	assumed	0.01	0.93	-0.40	8.00	0.70	-0.02	0.05	-0.13	0.09
	not ass.			-0.40	7.88	0.70	-0.02	0.05	-0.13	0.09
Ealing	assumed	0.29	0.61	-0.16	8.00	0.87	-0.01	0.05	-0.13	0.11
	not ass.			-0.16	7.84	0.87	-0.01	0.05	-0.13	0.11
Southall	assumed	0.03	0.87	-0.30	8.00	0.77	-0.01	0.03	-0.08	0.06
	not ass.			-0.30	8.00	0.77	-0.01	0.03	-0.08	0.06
Acton	assumed	0.05	0.82	-0.24	8.00	0.82	-0.01	0.04	-0.09	0.08
	not ass.			-0.24	7.95	0.82	-0.01	0.04	-0.09	0.08
Stanley Gardens	assumed	0.11	0.75	-0.02	8.00	0.98	0.00	0.04	-0.10	0.10
	not ass.			-0.02	7.80	0.98	0.00	0.04	-0.10	0.10
Askew Road	assumed	0.25	0.63	-0.05	8.00	0.96	0.00	0.05	-0.12	0.11
	not ass.			-0.05	7.85	0.96	0.00	0.05	-0.12	0.11
Hayes Town	assumed	0.04	0.84	-0.10	8.00	0.92	0.00	0.04	-0.09	0.08
	not ass.			-0.10	7.86	0.92	0.00	0.04	-0.09	0.08
Canary Wharf	assumed	0.40	0.54	-0.40	8.00	0.70	-0.03	0.09	-0.23	0.16
	not ass.			-0.40	7.51	0.70	-0.03	0.09	-0.24	0.17
Woolwich	assumed	0.22	0.65	-0.42	8.00	0.69	-0.02	0.04	-0.12	0.08
	not ass.			-0.42	7.79	0.69	-0.02	0.04	-0.12	0.08
Erith	assumed	0.16	0.70	-0.25	8.00	0.81	-0.01	0.02	-0.05	0.04
	not ass.			-0.25	7.98	0.81	-0.01	0.02	-0.05	0.04
West London	assumed	0.24	0.63	-0.07	8.00	0.95	0.00	0.06	-0.14	0.13
	not ass.			-0.07	7.85	0.95	0.00	0.06	-0.14	0.13
Walworth	assumed	0.15	0.71	-0.31	8.00	0.77	-0.01	0.04	-0.11	0.08
	not ass.			-0.31	7.75	0.77	-0.01	0.04	-0.11	0.08
Brentford	assumed	0.02	0.90	-0.17	8.00	0.87	-0.01	0.05	-0.12	0.10
	not ass.			-0.17	7.88	0.87	-0.01	0.05	-0.12	0.10
Oval	assumed	0.32	0.59	-0.26	8.00	0.80	-0.01	0.06	-0.15	0.12
	not ass.			-0.26	7.61	0.80	-0.01	0.06	-0.15	0.12
Greenwich	assumed	0.08	0.78	-0.18	8.00	0.86	-0.01	0.04	-0.10	0.09
	not ass.			-0.18	7.97	0.86	-0.01	0.04	-0.10	0.09
Battersea Riverside	assumed	0.28	0.61	0.00	8.00	1.00	0.00	0.06	-0.13	0.13
	not ass.			0.00	7.77	1.00	0.00	0.06	-0.13	0.14

Deptford	assumed	0.06	0.82	-0.26	8.00	0.80	-0.01	0.03	-0.08	0.06
	not ass.			-0.26	7.86	0.80	-0.01	0.03	-0.08	0.06
Munster Road,Fulham	assumed	0.17	0.69	-0.11	8.00	0.92	-0.01	0.06	-0.14	0.12
	not ass.			-0.11	7.75	0.92	-0.01	0.06	-0.14	0.12
Central London	assumed	0.35	0.57	-0.19	8.00	0.85	-0.01	0.07	-0.17	0.15
	not ass.			-0.19	7.74	0.85	-0.01	0.07	-0.18	0.15
Battersea	assumed	0.08	0.78	-0.19	8.00	0.85	-0.01	0.05	-0.11	0.10
	not ass.			-0.19	7.93	0.85	-0.01	0.05	-0.11	0.10
Barnes High Street	assumed	0.04	0.84	-0.08	8.00	0.94	0.00	0.05	-0.13	0.12
	not ass.			-0.08	7.92	0.94	0.00	0.05	-0.13	0.12
Sands End	assumed	0.01	0.94	0.00	8.00	1.00	0.00	0.04	-0.10	0.10
	not ass.			0.00	8.00	1.00	0.00	0.04	-0.10	0.10
Latchmere Road,Battersea	assumed	0.19	0.67	0.04	8.00	0.97	0.00	0.05	-0.11	0.12
	not ass.			0.04	7.86	0.97	0.00	0.05	-0.11	0.12
Camberwell	assumed	0.08	0.78	-0.35	8.00	0.73	-0.02	0.04	-0.12	0.09
	not ass.			-0.35	7.93	0.73	-0.02	0.04	-0.12	0.09
Peckham	assumed	0.10	0.77	-0.30	8.00	0.77	-0.01	0.04	-0.11	0.08
	not ass.			-0.30	7.95	0.77	-0.01	0.04	-0.11	0.08
Barnes	assumed	0.02	0.88	-0.12	8.00	0.91	-0.01	0.06	-0.15	0.13
	not ass.			-0.12	7.91	0.91	-0.01	0.06	-0.15	0.13
Blackheath	assumed	0.19	0.67	-0.24	8.00	0.81	-0.01	0.05	-0.13	0.10
	not ass.			-0.24	7.89	0.81	-0.01	0.05	-0.13	0.10
Fulham	assumed	0.09	0.77	-0.01	8.00	0.99	0.00	0.05	-0.11	0.11
	not ass.			-0.01	7.96	0.99	0.00	0.05	-0.11	0.11
Welling	assumed	0.10	0.76	-0.10	8.00	0.92	0.00	0.03	-0.08	0.07
	not ass.			-0.10	7.99	0.92	0.00	0.03	-0.08	0.07
Heathrow	assumed	2.32	0.17	-0.41	8.00	0.69	-0.02	0.05	-0.14	0.09
	not ass.			-0.41	7.14	0.69	-0.02	0.05	-0.14	0.10
Lavender Hill	assumed	0.06	0.81	-0.13	8.00	0.90	-0.01	0.04	-0.11	0.10
	not ass.			-0.13	7.98	0.90	-0.01	0.04	-0.11	0.10
Hounslow	assumed	0.33	0.58	-0.22	8.00	0.83	-0.01	0.04	-0.11	0.09
	not ass.			-0.22	7.80	0.83	-0.01	0.04	-0.11	0.09
East Sheen	assumed	0.18	0.68	-0.10	8.00	0.92	-0.01	0.05	-0.13	0.12
	not ass.			-0.10	7.91	0.92	-0.01	0.05	-0.13	0.12
Clapham	assumed	0.15	0.71	-0.30	8.00	0.77	-0.02	0.05	-0.13	0.10
	not ass.			-0.30	7.90	0.77	-0.02	0.05	-0.13	0.10
Lewisham	assumed	0.24	0.64	-0.30	8.00	0.78	-0.01	0.05	-0.13	0.10
	not ass.			-0.30	7.83	0.78	-0.01	0.05	-0.13	0.10
Brixton	assumed	0.17	0.69	-0.34	8.00	0.74	-0.02	0.05	-0.13	0.10

	not ass.			-0.34	7.91	0.74	-0.02	0.05	-0.13	0.10
Bexleyheath	assumed	0.02	0.88	-0.13	8.00	0.90	0.00	0.04	-0.09	0.08
	not ass.			-0.13	7.96	0.90	0.00	0.04	-0.09	0.08
East Dulwich	assumed	0.07	0.80	-0.12	8.00	0.91	0.00	0.04	-0.09	0.08
	not ass.			-0.12	7.99	0.91	0.00	0.04	-0.09	0.08
Lee Green,Lewisham	assumed	0.10	0.76	-0.21	8.00	0.84	-0.01	0.04	-0.11	0.09
	not ass.			-0.21	7.97	0.84	-0.01	0.04	-0.11	0.09
Putney	assumed	0.24	0.63	-0.13	8.00	0.90	-0.01	0.05	-0.13	0.12
	not ass.			-0.13	7.88	0.90	-0.01	0.05	-0.13	0.12
Clapham Junction	assumed	0.11	0.74	-0.08	8.00	0.94	0.00	0.04	-0.11	0.10
	not ass.			-0.08	7.99	0.94	0.00	0.04	-0.11	0.10
Crayford	assumed	0.14	0.72	-0.23	8.00	0.82	-0.01	0.02	-0.06	0.05
	not ass.			-0.23	7.93	0.82	-0.01	0.02	-0.06	0.05
Richmond,London	assumed	0.22	0.65	-0.08	8.00	0.94	0.00	0.06	-0.13	0.12
	not ass.			-0.08	7.93	0.94	0.00	0.06	-0.13	0.12
Wandsworth	assumed	0.24	0.64	-0.18	8.00	0.86	-0.01	0.05	-0.13	0.11
	not ass.			-0.18	7.78	0.86	-0.01	0.05	-0.13	0.11
Richmond Bridge	assumed	0.37	0.56	-0.02	8.00	0.98	0.00	0.06	-0.13	0.13
	not ass.			-0.02	7.78	0.98	0.00	0.06	-0.13	0.13
Eltham	assumed	0.07	0.80	0.12	8.00	0.91	0.00	0.03	-0.06	0.07
	not ass.			0.12	7.98	0.91	0.00	0.03	-0.06	0.07
St Margarets	assumed	0.03	0.88	-0.01	8.00	0.99	0.00	0.04	-0.10	0.10
	not ass.			-0.01	7.95	0.99	0.00	0.04	-0.10	0.10
Catford	assumed	0.36	0.57	-0.36	8.00	0.72	-0.02	0.05	-0.15	0.11
	not ass.			-0.36	7.82	0.72	-0.02	0.05	-0.15	0.11
Twickenham	assumed	0.12	0.74	0.01	8.00	0.99	0.00	0.04	-0.10	0.10
	not ass.			0.01	7.93	0.99	0.00	0.04	-0.10	0.10
Balham	assumed	0.14	0.72	-0.28	8.00	0.78	-0.01	0.05	-0.12	0.10
	not ass.			-0.28	7.97	0.78	-0.01	0.05	-0.12	0.10
Forest Hill	assumed	0.13	0.73	-0.31	8.00	0.77	-0.01	0.04	-0.11	0.09
	not ass.			-0.31	7.85	0.77	-0.01	0.04	-0.11	0.09
Feltham	assumed	0.28	0.61	-0.38	8.00	0.71	-0.02	0.04	-0.12	0.08
	not ass.			-0.38	7.70	0.71	-0.02	0.04	-0.12	0.08
Station Road, Sidcup	assumed	0.23	0.65	-0.30	8.00	0.77	-0.02	0.05	-0.13	0.10
	not ass.			-0.30	7.80	0.77	-0.02	0.05	-0.14	0.10
Upper Tooting	assumed	0.24	0.64	-0.30	8.00	0.77	-0.02	0.06	-0.15	0.11
	not ass.			-0.30	7.85	0.77	-0.02	0.06	-0.15	0.11
West Norwood	assumed	0.02	0.90	-0.30	8.00	0.77	-0.01	0.04	-0.10	0.07
	not ass.			-0.30	7.94	0.77	-0.01	0.04	-0.10	0.07

Sidcup	assumed	0.41	0.54	-0.33	8.00	0.75	-0.02	0.06	-0.15	0.11
	not ass.			-0.33	7.70	0.75	-0.02	0.06	-0.15	0.11
Sydenham	assumed	0.02	0.89	-0.19	8.00	0.85	-0.01	0.04	-0.11	0.09
	not ass.			-0.19	7.99	0.85	-0.01	0.04	-0.11	0.09
Streatham	assumed	0.15	0.71	-0.23	8.00	0.82	-0.01	0.04	-0.11	0.09
	not ass.			-0.23	7.95	0.82	-0.01	0.04	-0.11	0.09
Tooting	assumed	0.17	0.69	-0.28	8.00	0.79	-0.01	0.05	-0.13	0.10
	not ass.			-0.28	7.90	0.79	-0.01	0.05	-0.13	0.10
Wimbledon Village	assumed	0.11	0.75	-0.12	8.00	0.91	-0.01	0.06	-0.14	0.13
	not ass.			-0.12	7.95	0.91	-0.01	0.06	-0.14	0.13
Chislehurst	assumed	0.05	0.83	-0.04	8.00	0.97	0.00	0.04	-0.09	0.09
	not ass.			-0.04	7.94	0.97	0.00	0.04	-0.09	0.09
Teddington	assumed	0.08	0.78	0.04	8.00	0.97	0.00	0.05	-0.10	0.11
	not ass.			0.04	7.85	0.97	0.00	0.05	-0.10	0.11
Upper Norwood	assumed	0.14	0.72	-0.27	8.00	0.80	-0.01	0.05	-0.12	0.10
	not ass.			-0.27	7.84	0.80	-0.01	0.05	-0.13	0.10
Wimbledon	assumed	0.14	0.72	-0.14	8.00	0.89	-0.01	0.04	-0.11	0.10
	not ass.			-0.14	7.95	0.89	-0.01	0.04	-0.11	0.10
Penge	assumed	0.07	0.79	-0.14	8.00	0.89	0.00	0.03	-0.07	0.06
	not ass.			-0.14	7.71	0.89	0.00	0.03	-0.07	0.07
Hampton Wick	assumed	0.23	0.65	-0.12	8.00	0.91	-0.01	0.06	-0.14	0.13
	not ass.			-0.12	7.71	0.91	-0.01	0.06	-0.14	0.13
Raynes Park	assumed	0.32	0.59	-0.06	8.00	0.95	0.00	0.05	-0.12	0.12
	not ass.			-0.06	7.69	0.95	0.00	0.05	-0.12	0.12
Norbiton	assumed	0.18	0.69	0.01	8.00	0.99	0.00	0.05	-0.10	0.10
	not ass.			0.01	7.85	0.99	0.00	0.05	-0.10	0.11
Beckenham	assumed	0.21	0.66	-0.23	8.00	0.82	-0.01	0.05	-0.12	0.09
	not ass.			-0.23	7.82	0.82	-0.01	0.05	-0.12	0.09
Norbury	assumed	0.07	0.79	-0.37	8.00	0.72	-0.02	0.06	-0.16	0.12
	not ass.			-0.37	7.99	0.72	-0.02	0.06	-0.16	0.12
Mitcham	assumed	0.04	0.84	-0.34	8.00	0.74	-0.02	0.05	-0.12	0.09
	not ass.			-0.34	7.83	0.74	-0.02	0.05	-0.12	0.09
Kingston-upon-Thames	assumed	0.10	0.76	0.01	8.00	0.99	0.00	0.04	-0.09	0.09
	not ass.			0.01	8.00	0.99	0.00	0.04	-0.09	0.09
Bromley	assumed	0.45	0.52	-0.24	8.00	0.82	-0.01	0.05	-0.14	0.11
	not ass.			-0.24	7.81	0.82	-0.01	0.05	-0.14	0.11
Morden	assumed	0.41	0.54	-0.29	8.00	0.78	-0.02	0.05	-0.14	0.11
	not ass.			-0.29	7.58	0.78	-0.02	0.05	-0.14	0.11
South Norwood	assumed	0.12	0.74	-0.26	8.00	0.80	-0.01	0.04	-0.11	0.08

	not ass.			-0.26	7.75	0.80	-0.01	0.04	-0.11	0.08
New Malden	assumed	0.38	0.56	-0.32	8.00	0.76	-0.02	0.05	-0.13	0.10
	not ass.			-0.32	7.72	0.76	-0.02	0.05	-0.13	0.10
Petts Wood	assumed	0.18	0.68	0.07	8.00	0.94	0.00	0.04	-0.09	0.10
	not ass.			0.07	7.87	0.94	0.00	0.04	-0.09	0.10
Surbiton	assumed	0.34	0.58	-0.05	8.00	0.96	0.00	0.05	-0.11	0.11
	not ass.			-0.05	7.83	0.96	0.00	0.05	-0.11	0.11
Tolworth	assumed	0.05	0.84	-0.27	8.00	0.80	-0.01	0.04	-0.11	0.09
	not ass.			-0.27	7.70	0.80	-0.01	0.04	-0.11	0.09
West Wickham	assumed	0.03	0.87	-0.09	8.00	0.93	0.00	0.03	-0.08	0.07
	not ass.			-0.09	8.00	0.93	0.00	0.03	-0.08	0.07
Orpington	assumed	0.11	0.75	-0.16	8.00	0.88	-0.01	0.04	-0.10	0.09
	not ass.			-0.16	7.91	0.88	-0.01	0.04	-0.10	0.09
Worcester Park	assumed	0.10	0.76	-0.08	8.00	0.94	0.00	0.04	-0.10	0.09
	not ass.			-0.08	7.84	0.94	0.00	0.04	-0.10	0.09
North Cheam	assumed	0.22	0.65	-0.07	8.00	0.94	0.00	0.04	-0.10	0.09
	not ass.			-0.07	7.80	0.94	0.00	0.04	-0.10	0.09
Croydon	assumed	0.52	0.49	-0.28	8.00	0.79	-0.01	0.05	-0.13	0.10
	not ass.			-0.28	7.66	0.79	-0.01	0.05	-0.13	0.11
Wallington	assumed	0.30	0.60	-0.20	8.00	0.85	-0.01	0.06	-0.14	0.12
	not ass.			-0.20	7.69	0.85	-0.01	0.06	-0.14	0.12
Cheam	assumed	0.34	0.58	-0.15	8.00	0.88	-0.01	0.05	-0.13	0.11
	not ass.			-0.15	7.72	0.88	-0.01	0.05	-0.13	0.11
Purley	assumed	0.29	0.61	-0.14	8.00	0.89	-0.01	0.04	-0.11	0.10
	not ass.			-0.14	7.78	0.89	-0.01	0.04	-0.11	0.10
Coulsdon	assumed	0.25	0.63	0.00	8.00	1.00	0.00	0.03	-0.08	0.08
	not ass.			0.00	7.76	1.00	0.00	0.03	-0.08	0.08
Angel,Islington	assumed	0.23	0.64	-0.20	8.00	0.84	-0.01	0.05	-0.14	0.11
	not ass.			-0.20	7.90	0.84	-0.01	0.05	-0.14	0.12
Camden High Street	assumed	0.29	0.60	-0.06	8.00	0.96	0.00	0.06	-0.14	0.14
	not ass.			-0.06	7.80	0.96	0.00	0.06	-0.14	0.14
Shoreditch	assumed	0.23	0.65	-0.14	8.00	0.89	-0.01	0.06	-0.15	0.14
	not ass.			-0.14	7.67	0.89	-0.01	0.06	-0.15	0.14
Edgware Road	assumed	0.18	0.69	-0.15	8.00	0.89	-0.01	0.06	-0.15	0.13
	not ass.			-0.15	7.88	0.89	-0.01	0.06	-0.15	0.13
Holborn	assumed	0.38	0.56	-0.17	8.00	0.87	-0.01	0.09	-0.21	0.18
	not ass.			-0.17	7.62	0.87	-0.01	0.09	-0.21	0.18
Liverpool Street and Bishopsgate	assumed	0.40	0.55	-0.35	8.00	0.73	-0.03	0.10	-0.26	0.19
	not ass.			-0.35	7.61	0.73	-0.03	0.10	-0.26	0.19

Portobello Road	assumed	0.00	1.00	0.16	8.00	0.87	0.01	0.04	-0.08	0.09
	not ass.			0.16	7.74	0.87	0.01	0.04	-0.08	0.09
Westbourne Grove	assumed	0.00	0.99	0.10	8.00	0.92	0.00	0.04	-0.09	0.10
	not ass.			0.10	7.85	0.92	0.00	0.04	-0.09	0.10
Cheapside	assumed	0.36	0.56	-0.33	8.00	0.75	-0.03	0.10	-0.27	0.20
	not ass.			-0.33	7.66	0.75	-0.03	0.10	-0.27	0.20
Leadenhall	assumed	0.35	0.57	-0.36	8.00	0.73	-0.04	0.10	-0.27	0.20
	not ass.			-0.36	7.67	0.73	-0.04	0.10	-0.27	0.20
Bayswater	assumed	0.09	0.78	0.07	8.00	0.95	0.00	0.04	-0.09	0.10
	not ass.			0.07	7.67	0.95	0.00	0.04	-0.09	0.10
Notting Hill Gate	assumed	0.09	0.77	-0.04	8.00	0.97	0.00	0.06	-0.13	0.13
	not ass.			-0.04	8.00	0.97	0.00	0.06	-0.13	0.13
West End,London	assumed	0.29	0.60	-0.14	8.00	0.89	-0.01	0.07	-0.18	0.16
	not ass.			-0.14	7.83	0.89	-0.01	0.07	-0.18	0.16
Kensington High Street	assumed	0.04	0.84	-0.04	8.00	0.97	0.00	0.06	-0.13	0.12
	not ass.			-0.04	8.00	0.97	0.00	0.06	-0.13	0.12
Knightsbridge	assumed	0.02	0.89	-0.11	8.00	0.91	-0.01	0.05	-0.13	0.12
	not ass.			-0.11	7.96	0.91	-0.01	0.05	-0.13	0.12
Victoria	assumed	0.36	0.56	-0.23	8.00	0.83	-0.02	0.08	-0.19	0.16
	not ass.			-0.23	7.76	0.83	-0.02	0.08	-0.19	0.16
South Kensington	assumed	0.13	0.73	-0.06	8.00	0.96	0.00	0.05	-0.11	0.11
	not ass.			-0.06	7.59	0.96	0.00	0.05	-0.11	0.11
Upper Brompton Road	assumed	0.14	0.72	-0.07	8.00	0.95	0.00	0.05	-0.12	0.11
	not ass.			-0.07	7.56	0.95	0.00	0.05	-0.12	0.11
Pimlico	assumed	0.39	0.55	-0.24	8.00	0.82	-0.02	0.08	-0.21	0.17
	not ass.			-0.24	7.65	0.82	-0.02	0.08	-0.21	0.17
Chiswick	assumed	0.00	0.95	0.02	8.00	0.98	0.00	0.05	-0.11	0.11
	not ass.			0.02	8.00	0.98	0.00	0.05	-0.11	0.11
Hammersmith	assumed	0.33	0.58	-0.09	8.00	0.93	-0.01	0.07	-0.16	0.15
	not ass.			-0.09	7.84	0.93	-0.01	0.07	-0.16	0.15
Kings Road,Chelsea	assumed	0.01	0.94	-0.12	8.00	0.91	-0.01	0.06	-0.14	0.12
	not ass.			-0.12	8.00	0.91	-0.01	0.06	-0.14	0.12
Fulham Retail Core	assumed	0.11	0.75	-0.04	8.00	0.97	0.00	0.05	-0.11	0.11
	not ass.			-0.04	7.98	0.97	0.00	0.05	-0.11	0.11
Croydon Retail Core	assumed	0.43	0.53	-0.26	8.00	0.80	-0.01	0.05	-0.14	0.11
	not ass.			-0.26	7.75	0.80	-0.01	0.05	-0.14	0.11

11.9.2 Scenario 2

Independent Samples Test

	Equal variance	Levene's Test for Equality of Variances F	Levene's Test Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Barnet	assumed	0.53	0.49	0.15	8.00	0.88	0.00	0.03	-0.06	0.07
	not ass.			0.15	7.62	0.88	0.00	0.03	-0.06	0.07
Enfield	assumed	0.75	0.41	0.00	8.00	1.00	0.00	0.03	-0.06	0.06
	not ass.			0.00	7.15	1.00	0.00	0.03	-0.06	0.06
New Barnet	assumed	0.19	0.67	0.22	8.00	0.83	0.01	0.03	-0.06	0.07
	not ass.			0.22	7.84	0.83	0.01	0.03	-0.06	0.07
Chingford	assumed	0.04	0.85	0.33	8.00	0.75	0.01	0.03	-0.06	0.08
	not ass.			0.33	7.99	0.75	0.01	0.03	-0.06	0.08
Southgate	assumed	0.26	0.62	0.37	8.00	0.72	0.01	0.02	-0.04	0.06
	not ass.			0.37	7.28	0.72	0.01	0.02	-0.05	0.06
Winchmore Hill	assumed	0.06	0.82	0.46	8.00	0.66	0.01	0.03	-0.05	0.08
	not ass.			0.46	8.00	0.66	0.01	0.03	-0.05	0.08
Whetstone	assumed	1.23	0.30	-0.30	8.00	0.77	-0.01	0.03	-0.08	0.06
	not ass.			-0.30	6.97	0.77	-0.01	0.03	-0.09	0.07
Lower Edmonton	assumed	0.00	0.96	-0.07	8.00	0.94	0.00	0.02	-0.06	0.05
	not ass.			-0.07	7.70	0.94	0.00	0.02	-0.06	0.05
Chingford Mount	assumed	0.36	0.56	0.61	8.00	0.56	0.02	0.03	-0.05	0.08
	not ass.			0.61	7.67	0.56	0.02	0.03	-0.05	0.08
Palmers Green	assumed	0.00	0.95	0.81	8.00	0.44	0.02	0.03	-0.04	0.08
	not ass.			0.81	7.99	0.44	0.02	0.03	-0.04	0.08
Stanmore	assumed	1.82	0.21	-0.32	8.00	0.76	-0.01	0.03	-0.08	0.06
	not ass.			-0.32	6.58	0.76	-0.01	0.03	-0.09	0.07
Upper Edmonton	assumed	0.20	0.67	-0.49	8.00	0.64	-0.01	0.02	-0.07	0.04
	not ass.			-0.49	8.00	0.64	-0.01	0.02	-0.07	0.04
Mill Hill	assumed	9.80	0.01	1.37	8.00	0.21	0.03	0.02	-0.02	0.08
	not ass.			1.37	4.61	0.23	0.03	0.02	-0.03	0.09
North Finchley	assumed	0.70	0.43	0.33	8.00	0.75	0.01	0.03	-0.05	0.07
	not ass.			0.33	7.15	0.75	0.01	0.03	-0.05	0.07
Northwood	assumed	0.32	0.59	-0.08	8.00	0.94	0.00	0.02	-0.06	0.06
	not ass.			-0.08	7.60	0.94	0.00	0.02	-0.06	0.06
Edgware	assumed	0.97	0.35	-0.25	8.00	0.81	-0.01	0.03	-0.07	0.06

	not ass.			-0.25	7.23	0.81	-0.01	0.03	-0.07	0.06
North Tottenham	assumed	0.32	0.59	-0.43	8.00	0.68	-0.01	0.03	-0.08	0.05
	not ass.			-0.43	8.00	0.68	-0.01	0.03	-0.08	0.05
Burnt Oak	assumed	1.08	0.33	-0.06	8.00	0.96	0.00	0.02	-0.05	0.05
	not ass.			-0.06	7.13	0.96	0.00	0.02	-0.05	0.05
Finchley	assumed	1.05	0.33	0.16	8.00	0.88	0.00	0.03	-0.06	0.07
	not ass.			0.16	6.75	0.88	0.00	0.03	-0.06	0.07
South Woodford	assumed	0.46	0.52	0.67	8.00	0.52	0.02	0.03	-0.04	0.08
	not ass.			0.67	7.77	0.52	0.02	0.03	-0.04	0.08
Tottenham	assumed	0.21	0.66	-0.82	8.00	0.44	-0.02	0.03	-0.09	0.04
	not ass.			-0.82	8.00	0.44	-0.02	0.03	-0.09	0.04
Barkingside	assumed	0.00	0.99	0.84	8.00	0.42	0.02	0.03	-0.04	0.08
	not ass.			0.84	8.00	0.42	0.02	0.03	-0.04	0.08
Wood Green	assumed	0.02	0.89	0.63	8.00	0.55	0.01	0.02	-0.04	0.07
	not ass.			0.63	7.99	0.55	0.01	0.02	-0.04	0.07
Wealdstone	assumed	0.03	0.88	-0.03	8.00	0.97	0.00	0.02	-0.05	0.05
	not ass.			-0.03	7.99	0.97	0.00	0.02	-0.05	0.05
Pinner	assumed	0.27	0.62	1.11	8.00	0.30	0.03	0.03	-0.03	0.09
	not ass.			1.11	8.00	0.30	0.03	0.03	-0.03	0.09
Muswell Hill	assumed	1.17	0.31	0.85	8.00	0.42	0.03	0.03	-0.04	0.09
	not ass.			0.85	7.19	0.42	0.03	0.03	-0.04	0.09
East Finchley	assumed	0.11	0.75	0.56	8.00	0.59	0.02	0.03	-0.05	0.08
	not ass.			0.56	7.97	0.59	0.02	0.03	-0.05	0.08
Brent Street	assumed	1.34	0.28	0.11	8.00	0.91	0.00	0.03	-0.07	0.07
	not ass.			0.11	6.78	0.91	0.00	0.03	-0.07	0.08
Kingsbury	assumed	2.88	0.13	1.15	8.00	0.28	0.03	0.02	-0.03	0.08
	not ass.			1.15	6.43	0.29	0.03	0.02	-0.03	0.08
Walthamstow	assumed	0.06	0.81	0.59	8.00	0.57	0.01	0.02	-0.04	0.06
	not ass.			0.59	7.98	0.57	0.01	0.02	-0.04	0.06
North Harrow	assumed	0.00	0.96	0.45	8.00	0.66	0.01	0.03	-0.06	0.08
	not ass.			0.45	7.93	0.66	0.01	0.03	-0.06	0.08
Hendon Central	assumed	1.05	0.33	1.33	8.00	0.22	0.04	0.03	-0.03	0.10
	not ass.			1.33	5.80	0.23	0.04	0.03	-0.03	0.10
Kenton	assumed	2.08	0.19	-0.41	8.00	0.69	-0.01	0.02	-0.05	0.04
	not ass.			-0.41	7.07	0.70	-0.01	0.02	-0.05	0.04
Temple Fortune	assumed	0.41	0.54	0.75	8.00	0.47	0.02	0.03	-0.04	0.09
	not ass.			0.75	7.75	0.47	0.02	0.03	-0.04	0.09
Romford	assumed	1.63	0.24	0.01	8.00	0.99	0.00	0.03	-0.06	0.06
	not ass.			0.01	7.24	0.99	0.00	0.03	-0.06	0.07

Gants Hill	assumed	0.15	0.71	-0.28	8.00	0.79	-0.01	0.03	-0.08	0.06
	not ass.			-0.28	7.93	0.79	-0.01	0.03	-0.08	0.06
Crouch End	assumed	1.47	0.26	0.84	8.00	0.42	0.02	0.03	-0.04	0.08
	not ass.			0.84	7.08	0.43	0.02	0.03	-0.04	0.08
Green Lanes	assumed	0.07	0.80	0.14	8.00	0.89	0.00	0.02	-0.05	0.06
	not ass.			0.14	8.00	0.89	0.00	0.02	-0.05	0.06
Bakers Arms	assumed	0.54	0.49	-0.37	8.00	0.72	-0.01	0.03	-0.07	0.05
	not ass.			-0.37	7.80	0.72	-0.01	0.03	-0.07	0.05
Chadwell Heath	assumed	0.18	0.68	0.06	8.00	0.96	0.00	0.03	-0.06	0.06
	not ass.			0.06	7.16	0.96	0.00	0.03	-0.06	0.06
Harrow	assumed	0.94	0.36	-0.07	8.00	0.95	0.00	0.03	-0.07	0.06
	not ass.			-0.07	7.11	0.95	0.00	0.03	-0.07	0.06
Brent Cross	assumed	1.89	0.21	1.25	8.00	0.25	0.05	0.04	-0.04	0.14
	not ass.			1.25	4.95	0.27	0.05	0.04	-0.05	0.15
Stamford Hill	assumed	1.26	0.29	-0.08	8.00	0.94	0.00	0.03	-0.07	0.06
	not ass.			-0.08	6.43	0.94	0.00	0.03	-0.07	0.07
Eastcote	assumed	0.39	0.55	0.98	8.00	0.36	0.03	0.03	-0.04	0.09
	not ass.			0.98	7.79	0.36	0.03	0.03	-0.04	0.09
Rayners Lane	assumed	0.02	0.89	0.38	8.00	0.71	0.01	0.03	-0.06	0.08
	not ass.			0.38	7.99	0.71	0.01	0.03	-0.06	0.08
Highgate	assumed	2.03	0.19	1.23	8.00	0.25	0.04	0.04	-0.04	0.13
	not ass.			1.23	5.30	0.27	0.04	0.04	-0.05	0.13
Leytonstone	assumed	0.39	0.55	0.19	8.00	0.86	0.00	0.03	-0.05	0.06
	not ass.			0.19	7.92	0.86	0.00	0.03	-0.05	0.06
Golders Green	assumed	0.01	0.93	0.38	8.00	0.71	0.01	0.03	-0.06	0.08
	not ass.			0.38	7.96	0.71	0.01	0.03	-0.06	0.08
Seven Kings	assumed	0.89	0.37	-0.32	8.00	0.76	-0.01	0.03	-0.08	0.06
	not ass.			-0.32	7.48	0.76	-0.01	0.03	-0.08	0.06
Ruislip	assumed	4.66	0.06	1.20	8.00	0.26	0.04	0.03	-0.03	0.10
	not ass.			1.20	6.25	0.27	0.04	0.03	-0.04	0.11
Ruislip Manor	assumed	0.25	0.63	0.40	8.00	0.70	0.01	0.03	-0.06	0.08
	not ass.			0.40	7.41	0.70	0.01	0.03	-0.06	0.08
Hornchurch	assumed	0.11	0.75	0.89	8.00	0.40	0.02	0.03	-0.04	0.09
	not ass.			0.89	7.96	0.40	0.02	0.03	-0.04	0.09
Archway	assumed	0.23	0.64	-0.65	8.00	0.53	-0.02	0.04	-0.11	0.06
	not ass.			-0.65	7.76	0.53	-0.02	0.04	-0.11	0.06
Finsbury Park	assumed	0.09	0.77	0.41	8.00	0.69	0.01	0.03	-0.05	0.07
	not ass.			0.41	8.00	0.69	0.01	0.03	-0.05	0.07
Upminster	assumed	1.63	0.24	0.75	8.00	0.48	0.02	0.03	-0.04	0.08

	not ass.			0.75	6.96	0.48	0.02	0.03	-0.04	0.08
South Harrow	assumed	0.03	0.88	1.22	8.00	0.26	0.02	0.02	-0.02	0.07
	not ass.			1.22	7.98	0.26	0.02	0.02	-0.02	0.07
Ilford	assumed	1.04	0.34	0.12	8.00	0.91	0.00	0.02	-0.05	0.06
	not ass.			0.12	6.89	0.91	0.00	0.02	-0.06	0.06
Stoke Newington	assumed	0.21	0.66	0.44	8.00	0.67	0.01	0.03	-0.05	0.08
	not ass.			0.44	7.84	0.67	0.01	0.03	-0.05	0.08
Wembley Park	assumed	0.10	0.76	-0.08	8.00	0.94	0.00	0.02	-0.06	0.05
	not ass.			-0.08	7.99	0.94	0.00	0.02	-0.06	0.05
Holloway Road	assumed	0.95	0.36	0.23	8.00	0.82	0.01	0.03	-0.05	0.07
	not ass.			0.23	7.67	0.82	0.01	0.03	-0.05	0.07
Hampstead	assumed	0.55	0.48	-0.30	8.00	0.77	-0.01	0.03	-0.08	0.06
	not ass.			-0.30	7.05	0.78	-0.01	0.03	-0.08	0.06
Cricklewood	assumed	0.13	0.73	0.59	8.00	0.57	0.02	0.03	-0.05	0.08
	not ass.			0.59	7.94	0.57	0.02	0.03	-0.05	0.08
Highgate Road	assumed	4.24	0.07	1.14	8.00	0.29	0.03	0.03	-0.03	0.10
	not ass.			1.14	6.21	0.30	0.03	0.03	-0.04	0.11
Sudbury Hill	assumed	0.06	0.81	1.55	8.00	0.16	0.03	0.02	-0.02	0.09
	not ass.			1.55	7.88	0.16	0.03	0.02	-0.02	0.09
Haverstock Hill	assumed	0.50	0.50	-0.22	8.00	0.83	-0.01	0.03	-0.07	0.06
	not ass.			-0.22	6.98	0.83	-0.01	0.03	-0.07	0.06
Wembley	assumed	0.69	0.43	-0.13	8.00	0.90	0.00	0.02	-0.06	0.05
	not ass.			-0.13	7.46	0.90	0.00	0.02	-0.06	0.05
Forest Gate	assumed	0.17	0.69	-0.07	8.00	0.95	0.00	0.02	-0.06	0.06
	not ass.			-0.07	8.00	0.95	0.00	0.02	-0.06	0.06
Willesden Green	assumed	0.56	0.47	0.06	8.00	0.95	0.00	0.03	-0.06	0.06
	not ass.			0.06	7.40	0.95	0.00	0.03	-0.06	0.06
Brondesbury Park	assumed	0.03	0.88	0.47	8.00	0.65	0.01	0.02	-0.04	0.07
	not ass.			0.47	7.98	0.65	0.01	0.02	-0.04	0.07
Dalston	assumed	1.50	0.25	1.06	8.00	0.32	0.03	0.03	-0.03	0.09
	not ass.			1.06	6.47	0.33	0.03	0.03	-0.04	0.10
West Hampstead	assumed	2.39	0.16	1.21	8.00	0.26	0.04	0.03	-0.03	0.10
	not ass.			1.21	5.44	0.28	0.04	0.03	-0.04	0.11
England's Lane	assumed	2.09	0.19	1.00	8.00	0.34	0.03	0.03	-0.04	0.10
	not ass.			1.00	6.35	0.35	0.03	0.03	-0.04	0.11
Hackney	assumed	0.33	0.58	0.07	8.00	0.95	0.00	0.03	-0.06	0.06
	not ass.			0.07	7.72	0.95	0.00	0.03	-0.06	0.06
Dagenham	assumed	0.93	0.36	-0.73	8.00	0.49	-0.02	0.02	-0.07	0.04
	not ass.			-0.73	6.65	0.49	-0.02	0.02	-0.07	0.04

Kentish Town	assumed	2.13	0.18	1.46	8.00	0.18	0.05	0.03	-0.03	0.13
	not ass.			1.46	5.01	0.20	0.05	0.03	-0.04	0.13
Finchley Road,Swiss Cottage	assumed	0.99	0.35	0.89	8.00	0.40	0.03	0.03	-0.04	0.09
	not ass.			0.89	7.32	0.40	0.03	0.03	-0.04	0.09
Stratford	assumed	1.44	0.26	-0.40	8.00	0.70	-0.01	0.02	-0.06	0.04
	not ass.			-0.40	7.06	0.70	-0.01	0.02	-0.06	0.04
Caledonian Road	assumed	0.65	0.44	0.74	8.00	0.48	0.02	0.02	-0.03	0.07
	not ass.			0.74	7.71	0.48	0.02	0.02	-0.03	0.07
Barking	assumed	1.31	0.29	-0.37	8.00	0.72	-0.01	0.03	-0.08	0.06
	not ass.			-0.37	7.24	0.72	-0.01	0.03	-0.08	0.06
Uxbridge	assumed	1.12	0.32	-0.23	8.00	0.82	0.00	0.02	-0.05	0.04
	not ass.			-0.23	6.17	0.82	0.00	0.02	-0.05	0.04
Upton Park	assumed	0.04	0.84	0.52	8.00	0.62	0.01	0.03	-0.05	0.08
	not ass.			0.52	7.88	0.62	0.01	0.03	-0.05	0.08
Kilburn	assumed	1.20	0.30	0.98	8.00	0.36	0.03	0.03	-0.04	0.09
	not ass.			0.98	7.07	0.36	0.03	0.03	-0.04	0.09
East Ham	assumed	2.15	0.18	0.01	8.00	0.99	0.00	0.02	-0.05	0.06
	not ass.			0.01	6.90	0.99	0.00	0.02	-0.06	0.06
Kensal Rise	assumed	2.70	0.14	1.46	8.00	0.18	0.05	0.03	-0.03	0.13
	not ass.			1.46	5.25	0.20	0.05	0.03	-0.04	0.13
Bow	assumed	0.01	0.93	-0.71	8.00	0.50	-0.02	0.03	-0.08	0.04
	not ass.			-0.71	7.76	0.50	-0.02	0.03	-0.08	0.04
Harlesden	assumed	2.47	0.15	0.91	8.00	0.39	0.02	0.02	-0.03	0.08
	not ass.			0.91	6.86	0.39	0.02	0.02	-0.03	0.08
Camden Town	assumed	0.56	0.48	1.24	8.00	0.25	0.03	0.03	-0.03	0.10
	not ass.			1.24	6.45	0.26	0.03	0.03	-0.03	0.10
St Johns Wood	assumed	0.86	0.38	-0.19	8.00	0.86	-0.01	0.03	-0.08	0.07
	not ass.			-0.19	7.07	0.86	-0.01	0.03	-0.08	0.07
Bethnal Green	assumed	0.40	0.54	0.14	8.00	0.89	0.00	0.02	-0.05	0.06
	not ass.			0.14	7.85	0.89	0.00	0.02	-0.05	0.06
Maida Vale	assumed	1.26	0.29	1.08	8.00	0.31	0.04	0.03	-0.04	0.11
	not ass.			1.08	6.74	0.32	0.04	0.03	-0.04	0.12
Kensal Town	assumed	1.48	0.26	1.17	8.00	0.28	0.04	0.03	-0.04	0.11
	not ass.			1.17	6.40	0.28	0.04	0.03	-0.04	0.12
Greenford	assumed	0.84	0.39	0.93	8.00	0.38	0.02	0.02	-0.02	0.06
	not ass.			0.93	7.80	0.38	0.02	0.02	-0.02	0.06
Maida Hill	assumed	0.31	0.60	0.76	8.00	0.47	0.02	0.03	-0.04	0.09
	not ass.			0.76	7.89	0.47	0.02	0.03	-0.04	0.09
Mile End Road	assumed	0.41	0.54	-0.59	8.00	0.57	-0.02	0.03	-0.10	0.06

	not ass.			-0.59	7.54	0.57	-0.02	0.03	-0.10	0.06
North Kensington	assumed	1.11	0.32	1.37	8.00	0.21	0.05	0.03	-0.03	0.12
	not ass.			1.37	5.89	0.22	0.05	0.03	-0.04	0.13
Limehouse	assumed	0.40	0.55	-0.38	8.00	0.72	-0.01	0.03	-0.08	0.06
	not ass.			-0.38	7.77	0.72	-0.01	0.03	-0.08	0.06
Yiewsley	assumed	0.04	0.85	-1.49	8.00	0.17	-0.05	0.03	-0.12	0.02
	not ass.			-1.49	7.87	0.17	-0.05	0.03	-0.12	0.02
Ealing	assumed	0.19	0.68	0.37	8.00	0.72	0.01	0.03	-0.05	0.07
	not ass.			0.37	7.65	0.72	0.01	0.03	-0.05	0.07
Southall	assumed	0.78	0.40	-0.17	8.00	0.87	0.00	0.03	-0.07	0.06
	not ass.			-0.17	7.88	0.87	0.00	0.03	-0.07	0.06
Acton	assumed	0.01	0.91	0.21	8.00	0.84	0.01	0.03	-0.05	0.06
	not ass.			0.21	7.99	0.84	0.01	0.03	-0.05	0.06
Stanley Gardens	assumed	4.95	0.06	1.25	8.00	0.25	0.04	0.03	-0.03	0.11
	not ass.			1.25	5.12	0.26	0.04	0.03	-0.04	0.11
Askew Road	assumed	2.17	0.18	1.42	8.00	0.19	0.04	0.03	-0.03	0.11
	not ass.			1.42	5.81	0.21	0.04	0.03	-0.03	0.11
Hayes Town	assumed	0.00	0.99	0.11	8.00	0.91	0.00	0.02	-0.05	0.06
	not ass.			0.11	8.00	0.91	0.00	0.02	-0.05	0.06
Canary Wharf	assumed	0.15	0.71	-0.87	8.00	0.41	-0.04	0.05	-0.16	0.07
	not ass.			-0.87	7.79	0.41	-0.04	0.05	-0.16	0.07
Woolwich	assumed	1.09	0.33	-0.36	8.00	0.73	-0.01	0.03	-0.07	0.05
	not ass.			-0.36	7.29	0.73	-0.01	0.03	-0.07	0.05
Erith	assumed	0.06	0.81	-0.29	8.00	0.78	-0.01	0.02	-0.06	0.05
	not ass.			-0.29	7.37	0.78	-0.01	0.02	-0.06	0.05
West London	assumed	0.41	0.54	0.98	8.00	0.35	0.03	0.03	-0.04	0.09
	not ass.			0.98	7.44	0.36	0.03	0.03	-0.04	0.09
Walworth	assumed	0.11	0.75	0.26	8.00	0.80	0.01	0.03	-0.05	0.07
	not ass.			0.26	7.96	0.80	0.01	0.03	-0.05	0.07
Brentford	assumed	0.15	0.71	0.16	8.00	0.87	0.00	0.03	-0.06	0.07
	not ass.			0.16	7.61	0.87	0.00	0.03	-0.06	0.07
Oval	assumed	0.19	0.68	0.29	8.00	0.78	0.01	0.03	-0.05	0.07
	not ass.			0.29	7.46	0.78	0.01	0.03	-0.05	0.07
Greenwich	assumed	0.24	0.64	0.73	8.00	0.49	0.02	0.02	-0.04	0.07
	not ass.			0.73	7.86	0.49	0.02	0.02	-0.04	0.07
Battersea Riverside	assumed	2.98	0.12	1.31	8.00	0.23	0.04	0.03	-0.03	0.11
	not ass.			1.31	4.77	0.25	0.04	0.03	-0.04	0.12
Deptford	assumed	0.02	0.90	0.22	8.00	0.83	0.00	0.02	-0.05	0.06
	not ass.			0.22	7.87	0.83	0.00	0.02	-0.05	0.06

Munster Road,Fulham	assumed	0.99	0.35	0.73	8.00	0.48	0.02	0.03	-0.05	0.09
	not ass.			0.73	7.37	0.49	0.02	0.03	-0.05	0.09
Central London	assumed	0.81	0.39	0.11	8.00	0.91	0.00	0.03	-0.06	0.07
	not ass.			0.11	6.27	0.91	0.00	0.03	-0.07	0.07
Battersea	assumed	0.05	0.83	0.16	8.00	0.88	0.00	0.02	-0.04	0.05
	not ass.			0.16	7.98	0.88	0.00	0.02	-0.04	0.05
Barnes High Street	assumed	2.14	0.18	0.76	8.00	0.47	0.02	0.03	-0.05	0.10
	not ass.			0.76	6.60	0.48	0.02	0.03	-0.05	0.10
Sands End	assumed	1.13	0.32	0.86	8.00	0.41	0.03	0.03	-0.04	0.10
	not ass.			0.86	7.36	0.42	0.03	0.03	-0.05	0.10
Latchmere Road,Battersea	assumed	2.26	0.17	1.35	8.00	0.21	0.04	0.03	-0.03	0.11
	not ass.			1.35	4.57	0.24	0.04	0.03	-0.04	0.12
Camberwell	assumed	0.42	0.54	-0.59	8.00	0.57	-0.02	0.04	-0.10	0.06
	not ass.			-0.59	7.86	0.57	-0.02	0.04	-0.10	0.06
Peckham	assumed	0.06	0.81	0.60	8.00	0.57	0.01	0.02	-0.04	0.06
	not ass.			0.60	7.95	0.57	0.01	0.02	-0.04	0.06
Barnes	assumed	2.89	0.13	0.78	8.00	0.46	0.02	0.03	-0.04	0.09
	not ass.			0.78	5.91	0.46	0.02	0.03	-0.05	0.09
Blackheath	assumed	0.62	0.45	0.16	8.00	0.88	0.00	0.03	-0.06	0.07
	not ass.			0.16	7.58	0.88	0.00	0.03	-0.06	0.07
Fulham	assumed	1.36	0.28	1.01	8.00	0.34	0.03	0.03	-0.04	0.11
	not ass.			1.01	7.06	0.35	0.03	0.03	-0.04	0.11
Welling	assumed	0.25	0.63	0.93	8.00	0.38	0.03	0.03	-0.04	0.10
	not ass.			0.93	7.71	0.38	0.03	0.03	-0.04	0.10
Heathrow	assumed	0.10	0.77	-1.01	8.00	0.34	-0.06	0.06	-0.21	0.08
	not ass.			-1.01	7.71	0.34	-0.06	0.06	-0.21	0.08
Lavender Hill	assumed	0.67	0.44	0.85	8.00	0.42	0.02	0.03	-0.04	0.09
	not ass.			0.85	7.47	0.42	0.02	0.03	-0.04	0.09
Hounslow	assumed	0.89	0.37	0.30	8.00	0.77	0.01	0.02	-0.04	0.05
	not ass.			0.30	6.50	0.77	0.01	0.02	-0.04	0.06
East Sheen	assumed	0.27	0.62	0.62	8.00	0.55	0.02	0.03	-0.05	0.08
	not ass.			0.62	7.98	0.55	0.02	0.03	-0.05	0.08
Clapham	assumed	0.50	0.50	0.24	8.00	0.81	0.01	0.03	-0.06	0.07
	not ass.			0.24	7.72	0.81	0.01	0.03	-0.06	0.07
Lewisham	assumed	1.25	0.30	-0.16	8.00	0.88	0.00	0.03	-0.07	0.06
	not ass.			-0.16	6.97	0.88	0.00	0.03	-0.07	0.06
Brixton	assumed	0.72	0.42	0.39	8.00	0.70	0.01	0.03	-0.05	0.07
	not ass.			0.39	7.52	0.70	0.01	0.03	-0.05	0.07
Bexleyheath	assumed	0.14	0.72	0.28	8.00	0.79	0.01	0.03	-0.06	0.08

	not ass.			0.28	7.99	0.79	0.01	0.03	-0.06	0.08
East Dulwich	assumed	0.04	0.85	0.76	8.00	0.47	0.02	0.03	-0.04	0.08
	not ass.			0.76	7.89	0.47	0.02	0.03	-0.04	0.08
Lee Green,Lewisham	assumed	0.14	0.72	0.24	8.00	0.82	0.01	0.03	-0.06	0.07
	not ass.			0.24	7.90	0.82	0.01	0.03	-0.06	0.07
Putney	assumed	0.11	0.75	0.72	8.00	0.49	0.02	0.03	-0.04	0.08
	not ass.			0.72	8.00	0.49	0.02	0.03	-0.04	0.08
Clapham Junction	assumed	0.87	0.38	0.79	8.00	0.45	0.02	0.03	-0.04	0.09
	not ass.			0.79	7.59	0.45	0.02	0.03	-0.04	0.09
Crayford	assumed	0.22	0.65	0.44	8.00	0.67	0.01	0.03	-0.05	0.07
	not ass.			0.44	7.42	0.67	0.01	0.03	-0.05	0.07
Richmond,London	assumed	0.24	0.64	0.84	8.00	0.43	0.02	0.03	-0.04	0.09
	not ass.			0.84	7.95	0.43	0.02	0.03	-0.04	0.09
Wandsworth	assumed	0.05	0.84	0.72	8.00	0.49	0.02	0.02	-0.04	0.07
	not ass.			0.72	8.00	0.49	0.02	0.02	-0.04	0.07
Richmond Bridge	assumed	0.77	0.41	1.29	8.00	0.23	0.03	0.03	-0.03	0.10
	not ass.			1.29	6.26	0.24	0.03	0.03	-0.03	0.10
Eltham	assumed	0.51	0.49	1.41	8.00	0.20	0.03	0.02	-0.02	0.09
	not ass.			1.41	7.45	0.20	0.03	0.02	-0.02	0.09
St Margarets	assumed	0.69	0.43	0.74	8.00	0.48	0.02	0.03	-0.04	0.08
	not ass.			0.74	7.49	0.48	0.02	0.03	-0.04	0.08
Catford	assumed	2.07	0.19	-0.09	8.00	0.93	0.00	0.03	-0.06	0.06
	not ass.			-0.09	6.29	0.93	0.00	0.03	-0.07	0.06
Twickenham	assumed	1.15	0.31	0.99	8.00	0.35	0.02	0.02	-0.03	0.08
	not ass.			0.99	7.45	0.35	0.02	0.02	-0.03	0.08
Balham	assumed	1.15	0.31	-0.02	8.00	0.98	0.00	0.03	-0.07	0.07
	not ass.			-0.02	7.12	0.98	0.00	0.03	-0.07	0.07
Forest Hill	assumed	0.28	0.61	0.06	8.00	0.96	0.00	0.03	-0.06	0.07
	not ass.			0.06	7.95	0.96	0.00	0.03	-0.06	0.07
Feltham	assumed	0.73	0.42	-0.38	8.00	0.71	-0.01	0.02	-0.07	0.05
	not ass.			-0.38	7.24	0.71	-0.01	0.02	-0.07	0.05
Station Road, Sidcup	assumed	0.62	0.45	-0.32	8.00	0.76	-0.01	0.03	-0.08	0.06
	not ass.			-0.32	7.44	0.76	-0.01	0.03	-0.08	0.06
Upper Tooting	assumed	0.66	0.44	-0.53	8.00	0.61	-0.02	0.03	-0.09	0.05
	not ass.			-0.53	7.01	0.61	-0.02	0.03	-0.09	0.06
West Norwood	assumed	0.01	0.92	0.35	8.00	0.73	0.01	0.03	-0.06	0.08
	not ass.			0.35	7.79	0.73	0.01	0.03	-0.06	0.08
Sidcup	assumed	0.61	0.46	-0.43	8.00	0.68	-0.01	0.03	-0.09	0.06
	not ass.			-0.43	7.43	0.68	-0.01	0.03	-0.09	0.06

Sydenham	assumed	0.60	0.46	0.63	8.00	0.54	0.02	0.03	-0.04	0.08
	not ass.			0.63	7.48	0.54	0.02	0.03	-0.04	0.08
Streatham	assumed	0.09	0.77	0.57	8.00	0.58	0.01	0.03	-0.04	0.07
	not ass.			0.57	7.94	0.58	0.01	0.03	-0.04	0.07
Tooting	assumed	0.74	0.42	-0.62	8.00	0.55	-0.02	0.03	-0.08	0.04
	not ass.			-0.62	6.96	0.56	-0.02	0.03	-0.08	0.05
Wimbledon Village	assumed	0.03	0.87	0.32	8.00	0.76	0.01	0.03	-0.06	0.08
	not ass.			0.32	7.78	0.76	0.01	0.03	-0.06	0.08
Chislehurst	assumed	1.59	0.24	0.84	8.00	0.43	0.02	0.03	-0.04	0.08
	not ass.			0.84	7.17	0.43	0.02	0.03	-0.04	0.08
Teddington	assumed	0.73	0.42	1.33	8.00	0.22	0.02	0.02	-0.02	0.07
	not ass.			1.33	7.80	0.22	0.02	0.02	-0.02	0.07
Upper Norwood	assumed	0.00	0.95	0.39	8.00	0.71	0.01	0.03	-0.05	0.07
	not ass.			0.39	7.99	0.71	0.01	0.03	-0.05	0.07
Wimbledon	assumed	0.00	0.95	0.41	8.00	0.70	0.01	0.02	-0.05	0.06
	not ass.			0.41	7.97	0.70	0.01	0.02	-0.05	0.06
Penge	assumed	0.65	0.44	0.83	8.00	0.43	0.02	0.02	-0.03	0.07
	not ass.			0.83	7.05	0.43	0.02	0.02	-0.04	0.07
Hampton Wick	assumed	0.00	0.96	0.66	8.00	0.53	0.02	0.03	-0.05	0.09
	not ass.			0.66	7.97	0.53	0.02	0.03	-0.05	0.09
Raynes Park	assumed	1.20	0.31	1.05	8.00	0.33	0.03	0.02	-0.03	0.08
	not ass.			1.05	7.35	0.33	0.03	0.02	-0.03	0.08
Norbiton	assumed	2.06	0.19	1.33	8.00	0.22	0.04	0.03	-0.03	0.10
	not ass.			1.33	5.34	0.24	0.04	0.03	-0.03	0.11
Beckenham	assumed	0.29	0.60	-0.12	8.00	0.91	0.00	0.03	-0.07	0.06
	not ass.			-0.12	7.73	0.91	0.00	0.03	-0.07	0.06
Norbury	assumed	0.42	0.54	0.27	8.00	0.79	0.01	0.03	-0.07	0.09
	not ass.			0.27	7.53	0.79	0.01	0.03	-0.07	0.09
Mitcham	assumed	0.38	0.56	-0.20	8.00	0.84	-0.01	0.03	-0.07	0.06
	not ass.			-0.20	7.42	0.85	-0.01	0.03	-0.07	0.06
Kingston-upon-Thames	assumed	0.34	0.58	1.40	8.00	0.20	0.03	0.02	-0.02	0.09
	not ass.			1.40	7.50	0.20	0.03	0.02	-0.02	0.09
Bromley	assumed	1.44	0.26	0.19	8.00	0.86	0.01	0.03	-0.06	0.07
	not ass.			0.19	6.51	0.86	0.01	0.03	-0.06	0.07
Morden	assumed	0.24	0.64	0.34	8.00	0.74	0.01	0.02	-0.04	0.06
	not ass.			0.34	7.03	0.75	0.01	0.02	-0.04	0.06
South Norwood	assumed	0.02	0.88	0.14	8.00	0.89	0.00	0.03	-0.05	0.06
	not ass.			0.14	7.96	0.89	0.00	0.03	-0.05	0.06
New Malden	assumed	0.52	0.49	-0.42	8.00	0.69	-0.01	0.03	-0.08	0.06

	not ass.			-0.42	7.59	0.69	-0.01	0.03	-0.08	0.06
Petts Wood	assumed	3.56	0.10	1.64	8.00	0.14	0.05	0.03	-0.02	0.11
	not ass.			1.64	4.66	0.17	0.05	0.03	-0.03	0.12
Surbiton	assumed	0.66	0.44	1.30	8.00	0.23	0.03	0.02	-0.02	0.08
	not ass.			1.30	7.45	0.23	0.03	0.02	-0.02	0.08
Tolworth	assumed	0.32	0.59	-0.93	8.00	0.38	-0.02	0.02	-0.07	0.03
	not ass.			-0.93	6.69	0.39	-0.02	0.02	-0.07	0.03
West Wickham	assumed	0.01	0.93	0.62	8.00	0.55	0.02	0.03	-0.05	0.08
	not ass.			0.62	8.00	0.55	0.02	0.03	-0.05	0.08
Orpington	assumed	0.07	0.80	0.51	8.00	0.62	0.01	0.02	-0.04	0.06
	not ass.			0.51	8.00	0.62	0.01	0.02	-0.04	0.06
Worcester Park	assumed	1.41	0.27	0.90	8.00	0.39	0.02	0.03	-0.04	0.08
	not ass.			0.90	7.39	0.40	0.02	0.03	-0.04	0.08
North Cheam	assumed	0.67	0.44	0.84	8.00	0.43	0.02	0.03	-0.04	0.08
	not ass.			0.84	7.70	0.43	0.02	0.03	-0.04	0.08
Croydon	assumed	0.93	0.36	-0.07	8.00	0.94	0.00	0.02	-0.06	0.05
	not ass.			-0.07	6.14	0.94	0.00	0.02	-0.06	0.06
Wallington	assumed	0.08	0.78	0.46	8.00	0.65	0.01	0.03	-0.05	0.07
	not ass.			0.46	7.61	0.66	0.01	0.03	-0.05	0.07
Cheam	assumed	0.02	0.90	0.70	8.00	0.51	0.02	0.03	-0.04	0.08
	not ass.			0.70	7.99	0.51	0.02	0.03	-0.04	0.08
Purley	assumed	0.56	0.47	0.97	8.00	0.36	0.02	0.02	-0.03	0.07
	not ass.			0.97	7.88	0.36	0.02	0.02	-0.03	0.07
Coulsdon	assumed	1.71	0.23	1.06	8.00	0.32	0.02	0.02	-0.03	0.08
	not ass.			1.06	6.95	0.32	0.02	0.02	-0.03	0.08
Angel,Islington	assumed	0.52	0.49	0.47	8.00	0.65	0.01	0.03	-0.05	0.07
	not ass.			0.47	7.13	0.66	0.01	0.03	-0.05	0.07
Camden High Street	assumed	0.46	0.52	1.19	8.00	0.27	0.03	0.03	-0.03	0.10
	not ass.			1.19	6.58	0.28	0.03	0.03	-0.03	0.10
Shoreditch	assumed	0.12	0.74	0.64	8.00	0.54	0.02	0.03	-0.04	0.08
	not ass.			0.64	7.34	0.54	0.02	0.03	-0.05	0.08
Edgware Road	assumed	0.47	0.51	0.07	8.00	0.95	0.00	0.03	-0.06	0.07
	not ass.			0.07	7.26	0.95	0.00	0.03	-0.07	0.07
Holborn	assumed	0.94	0.36	0.17	8.00	0.87	0.01	0.03	-0.07	0.08
	not ass.			0.17	6.20	0.87	0.01	0.03	-0.07	0.08
Liverpool Street and Bishopsgate	assumed	0.36	0.57	-0.76	8.00	0.47	-0.04	0.06	-0.17	0.09
	not ass.			-0.76	7.58	0.47	-0.04	0.06	-0.17	0.09
Portobello Road	assumed	2.58	0.15	1.27	8.00	0.24	0.05	0.04	-0.04	0.14
	not ass.			1.27	4.97	0.26	0.05	0.04	-0.05	0.15

Westbourne Grove	assumed	2.01	0.19	1.10	8.00	0.30	0.04	0.04	-0.05	0.13
	not ass.			1.10	6.14	0.31	0.04	0.04	-0.05	0.14
Cheapside	assumed	0.35	0.57	-0.78	8.00	0.46	-0.05	0.06	-0.18	0.09
	not ass.			-0.78	7.60	0.46	-0.05	0.06	-0.18	0.09
Leadenhall	assumed	0.39	0.55	-0.84	8.00	0.43	-0.05	0.06	-0.19	0.09
	not ass.			-0.84	7.63	0.43	-0.05	0.06	-0.19	0.09
Bayswater	assumed	1.41	0.27	0.67	8.00	0.52	0.03	0.04	-0.07	0.12
	not ass.			0.67	7.00	0.52	0.03	0.04	-0.07	0.13
Notting Hill Gate	assumed	0.97	0.35	0.82	8.00	0.44	0.03	0.03	-0.05	0.11
	not ass.			0.82	7.23	0.44	0.03	0.03	-0.05	0.11
West End,London	assumed	0.11	0.75	0.33	8.00	0.75	0.01	0.03	-0.06	0.07
	not ass.			0.33	7.25	0.75	0.01	0.03	-0.06	0.08
Kensington High Street	assumed	1.25	0.30	0.75	8.00	0.47	0.03	0.03	-0.05	0.11
	not ass.			0.75	6.97	0.48	0.03	0.03	-0.06	0.11
Knightsbridge	assumed	0.31	0.59	0.01	8.00	0.99	0.00	0.04	-0.09	0.09
	not ass.			0.01	7.93	0.99	0.00	0.04	-0.09	0.09
Victoria	assumed	2.13	0.18	-0.22	8.00	0.83	-0.01	0.03	-0.08	0.07
	not ass.			-0.22	5.72	0.84	-0.01	0.03	-0.08	0.07
South Kensington	assumed	0.35	0.57	0.37	8.00	0.72	0.01	0.04	-0.08	0.11
	not ass.			0.37	7.46	0.72	0.01	0.04	-0.08	0.11
Upper Brompton Road	assumed	0.30	0.60	0.34	8.00	0.74	0.01	0.04	-0.08	0.11
	not ass.			0.34	7.49	0.74	0.01	0.04	-0.08	0.11
Pimlico	assumed	1.35	0.28	0.08	8.00	0.94	0.00	0.03	-0.06	0.07
	not ass.			0.08	5.67	0.94	0.00	0.03	-0.07	0.07
Chiswick	assumed	1.06	0.33	0.96	8.00	0.37	0.03	0.03	-0.04	0.10
	not ass.			0.96	7.25	0.37	0.03	0.03	-0.04	0.10
Hammersmith	assumed	0.36	0.56	1.19	8.00	0.27	0.03	0.03	-0.03	0.10
	not ass.			1.19	6.99	0.27	0.03	0.03	-0.03	0.10
Kings Road,Chelsea	assumed	0.24	0.64	0.10	8.00	0.93	0.00	0.03	-0.08	0.08
	not ass.			0.10	7.85	0.93	0.00	0.03	-0.08	0.08
Fulham Retail Core	assumed	1.17	0.31	1.04	8.00	0.33	0.03	0.03	-0.04	0.11
	not ass.			1.04	6.96	0.33	0.03	0.03	-0.04	0.11
Croydon Retail Core	assumed	1.55	0.25	0.04	8.00	0.97	0.00	0.03	-0.06	0.06
	not ass.			0.04	5.77	0.97	0.00	0.03	-0.06	0.06

11.9.3 Scenario 3

Independent Samples Test

	Equal variance	Levene's Test for Equality of Variances F	Sig.	t-test for Equality of Means t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Barnet	assumed	0.01	0.92	-0.21	8.00	0.84	-0.01	0.04	-0.11	0.09
	not ass.			-0.21	7.99	0.84	-0.01	0.04	-0.11	0.09
Enfield	assumed	2.46	0.16	-0.83	8.00	0.43	-0.01	0.02	-0.05	0.03
	not ass.			-0.83	6.96	0.43	-0.01	0.02	-0.06	0.03
New Barnet	assumed	0.34	0.58	-0.45	8.00	0.66	-0.01	0.03	-0.08	0.06
	not ass.			-0.45	7.98	0.66	-0.01	0.03	-0.08	0.06
Chingford	assumed	0.02	0.88	-0.21	8.00	0.84	-0.01	0.03	-0.08	0.07
	not ass.			-0.21	8.00	0.84	-0.01	0.03	-0.08	0.07
Southgate	assumed	0.21	0.66	-0.64	8.00	0.54	-0.02	0.02	-0.07	0.04
	not ass.			-0.64	7.93	0.54	-0.02	0.02	-0.07	0.04
Winchmore Hill	assumed	0.19	0.67	-0.37	8.00	0.72	-0.01	0.03	-0.08	0.06
	not ass.			-0.37	7.98	0.72	-0.01	0.03	-0.08	0.06
Whetstone	assumed	0.17	0.69	-0.37	8.00	0.72	-0.02	0.04	-0.11	0.08
	not ass.			-0.37	7.99	0.72	-0.02	0.04	-0.11	0.08
Lower Edmonton	assumed	0.33	0.58	-0.18	8.00	0.86	-0.01	0.03	-0.08	0.07
	not ass.			-0.18	7.64	0.86	-0.01	0.03	-0.08	0.07
Chingford Mount	assumed	0.74	0.41	-0.13	8.00	0.90	0.00	0.02	-0.04	0.04
	not ass.			-0.13	7.43	0.90	0.00	0.02	-0.04	0.04
Palmers Green	assumed	0.64	0.45	-0.28	8.00	0.79	-0.01	0.03	-0.06	0.05
	not ass.			-0.28	7.67	0.79	-0.01	0.03	-0.07	0.05
Stanmore	assumed	0.30	0.60	-0.31	8.00	0.77	-0.01	0.04	-0.12	0.09
	not ass.			-0.31	7.84	0.77	-0.01	0.04	-0.12	0.09
Upper Edmonton	assumed	0.31	0.59	-0.35	8.00	0.74	-0.01	0.03	-0.09	0.07
	not ass.			-0.35	7.77	0.74	-0.01	0.03	-0.09	0.07
Mill Hill	assumed	0.00	0.96	0.27	8.00	0.80	0.01	0.03	-0.06	0.08
	not ass.			0.27	7.93	0.80	0.01	0.03	-0.06	0.08
North Finchley	assumed	0.59	0.46	-0.45	8.00	0.66	-0.01	0.03	-0.08	0.05
	not ass.			-0.45	7.93	0.66	-0.01	0.03	-0.08	0.05
Northwood	assumed	0.01	0.91	-0.28	8.00	0.79	-0.01	0.04	-0.10	0.08
	not ass.			-0.28	7.86	0.79	-0.01	0.04	-0.10	0.08
Edgware	assumed	0.11	0.75	-0.33	8.00	0.75	-0.01	0.04	-0.10	0.07

	not ass.			-0.33	7.99	0.75	-0.01	0.04	-0.10	0.07
North Tottenham	assumed	0.42	0.54	-0.16	8.00	0.88	-0.01	0.04	-0.11	0.09
	not ass.			-0.16	7.66	0.88	-0.01	0.04	-0.11	0.09
Burnt Oak	assumed	0.42	0.54	-0.39	8.00	0.71	-0.01	0.03	-0.07	0.05
	not ass.			-0.39	7.89	0.71	-0.01	0.03	-0.07	0.05
Finchley	assumed	0.55	0.48	-0.55	8.00	0.60	-0.02	0.03	-0.08	0.05
	not ass.			-0.55	7.99	0.60	-0.02	0.03	-0.08	0.05
South Woodford	assumed	0.11	0.75	-0.23	8.00	0.82	-0.01	0.02	-0.06	0.05
	not ass.			-0.23	8.00	0.82	-0.01	0.02	-0.06	0.05
Tottenham	assumed	0.55	0.48	-0.41	8.00	0.69	-0.02	0.04	-0.10	0.07
	not ass.			-0.41	7.44	0.69	-0.02	0.04	-0.10	0.07
Barkingside	assumed	1.37	0.28	-0.34	8.00	0.75	-0.01	0.02	-0.05	0.04
	not ass.			-0.34	6.93	0.75	-0.01	0.02	-0.05	0.04
Wood Green	assumed	1.50	0.26	-0.30	8.00	0.77	-0.01	0.02	-0.05	0.04
	not ass.			-0.30	5.73	0.77	-0.01	0.02	-0.05	0.04
Wealdstone	assumed	0.44	0.53	-0.62	8.00	0.55	-0.02	0.03	-0.07	0.04
	not ass.			-0.62	7.98	0.55	-0.02	0.03	-0.07	0.04
Pinner	assumed	0.00	0.96	-0.56	8.00	0.59	-0.01	0.02	-0.05	0.03
	not ass.			-0.56	7.92	0.59	-0.01	0.02	-0.05	0.03
Muswell Hill	assumed	0.08	0.78	-0.24	8.00	0.82	-0.01	0.03	-0.07	0.05
	not ass.			-0.24	7.86	0.82	-0.01	0.03	-0.07	0.05
East Finchley	assumed	0.10	0.76	-0.27	8.00	0.79	-0.01	0.03	-0.09	0.07
	not ass.			-0.27	7.97	0.79	-0.01	0.03	-0.09	0.07
Brent Street	assumed	0.21	0.66	-0.29	8.00	0.78	-0.01	0.04	-0.10	0.08
	not ass.			-0.29	7.94	0.78	-0.01	0.04	-0.10	0.08
Kingsbury	assumed	0.21	0.66	-0.43	8.00	0.68	-0.01	0.02	-0.06	0.04
	not ass.			-0.43	7.27	0.68	-0.01	0.02	-0.06	0.04
Walthamstow	assumed	2.12	0.18	-0.44	8.00	0.67	-0.01	0.02	-0.05	0.03
	not ass.			-0.44	6.31	0.67	-0.01	0.02	-0.05	0.04
North Harrow	assumed	0.01	0.94	-0.25	8.00	0.81	-0.01	0.04	-0.11	0.09
	not ass.			-0.25	7.83	0.81	-0.01	0.04	-0.11	0.09
Hendon Central	assumed	0.58	0.47	-0.01	8.00	0.99	0.00	0.02	-0.04	0.04
	not ass.			-0.01	7.92	0.99	0.00	0.02	-0.04	0.04
Kenton	assumed	0.12	0.74	-0.36	8.00	0.73	-0.01	0.03	-0.08	0.05
	not ass.			-0.36	8.00	0.73	-0.01	0.03	-0.08	0.05
Temple Fortune	assumed	0.32	0.59	-0.25	8.00	0.81	-0.01	0.03	-0.07	0.05
	not ass.			-0.25	7.99	0.81	-0.01	0.03	-0.07	0.05
Romford	assumed	1.71	0.23	-0.41	8.00	0.70	-0.01	0.02	-0.06	0.04
	not ass.			-0.41	6.60	0.70	-0.01	0.02	-0.06	0.04

Gants Hill	assumed	0.10	0.76	-0.40	8.00	0.70	-0.02	0.04	-0.11	0.08
	not ass.			-0.40	7.99	0.70	-0.02	0.04	-0.11	0.08
Crouch End	assumed	0.07	0.80	-0.31	8.00	0.77	-0.01	0.03	-0.07	0.05
	not ass.			-0.31	7.81	0.77	-0.01	0.03	-0.07	0.05
Green Lanes	assumed	0.07	0.79	-0.15	8.00	0.88	-0.01	0.03	-0.08	0.07
	not ass.			-0.15	7.99	0.88	-0.01	0.03	-0.08	0.07
Bakers Arms	assumed	0.11	0.75	-0.26	8.00	0.80	-0.01	0.04	-0.11	0.09
	not ass.			-0.26	7.95	0.80	-0.01	0.04	-0.11	0.09
Chadwell Heath	assumed	0.04	0.85	-0.24	8.00	0.81	-0.01	0.03	-0.09	0.07
	not ass.			-0.24	7.99	0.81	-0.01	0.03	-0.09	0.07
Harrow	assumed	1.07	0.33	-0.65	8.00	0.53	-0.01	0.02	-0.07	0.04
	not ass.			-0.65	7.78	0.53	-0.01	0.02	-0.07	0.04
Brent Cross	assumed	0.44	0.53	0.13	8.00	0.90	0.01	0.05	-0.10	0.11
	not ass.			0.13	7.79	0.90	0.01	0.05	-0.10	0.11
Stamford Hill	assumed	0.49	0.50	-0.15	8.00	0.88	-0.01	0.04	-0.10	0.09
	not ass.			-0.15	7.81	0.88	-0.01	0.04	-0.11	0.09
Eastcote	assumed	0.00	0.97	-0.44	8.00	0.67	-0.01	0.03	-0.08	0.06
	not ass.			-0.44	7.43	0.67	-0.01	0.03	-0.09	0.06
Rayners Lane	assumed	0.00	1.00	-0.22	8.00	0.83	-0.01	0.04	-0.11	0.09
	not ass.			-0.22	7.93	0.83	-0.01	0.04	-0.11	0.09
Highgate	assumed	0.27	0.62	-0.27	8.00	0.79	-0.01	0.03	-0.08	0.06
	not ass.			-0.27	6.91	0.79	-0.01	0.03	-0.08	0.07
Leytonstone	assumed	0.29	0.61	-0.19	8.00	0.86	-0.01	0.03	-0.08	0.07
	not ass.			-0.19	7.85	0.86	-0.01	0.03	-0.08	0.07
Golders Green	assumed	0.14	0.72	-0.26	8.00	0.80	-0.01	0.04	-0.09	0.07
	not ass.			-0.26	8.00	0.80	-0.01	0.04	-0.09	0.07
Seven Kings	assumed	0.18	0.68	-0.29	8.00	0.78	-0.01	0.04	-0.10	0.08
	not ass.			-0.29	7.88	0.78	-0.01	0.04	-0.10	0.08
Ruislip	assumed	0.22	0.65	-0.29	8.00	0.78	-0.01	0.02	-0.06	0.04
	not ass.			-0.29	6.43	0.78	-0.01	0.02	-0.06	0.04
Ruislip Manor	assumed	0.01	0.93	-0.22	8.00	0.83	-0.01	0.04	-0.10	0.08
	not ass.			-0.22	7.83	0.83	-0.01	0.04	-0.10	0.08
Hornchurch	assumed	0.59	0.47	-0.25	8.00	0.81	0.00	0.01	-0.04	0.03
	not ass.			-0.25	7.67	0.81	0.00	0.01	-0.04	0.03
Archway	assumed	0.12	0.74	-0.37	8.00	0.72	-0.02	0.05	-0.14	0.10
	not ass.			-0.37	7.97	0.72	-0.02	0.05	-0.14	0.10
Finsbury Park	assumed	0.16	0.70	-0.14	8.00	0.89	0.00	0.03	-0.08	0.07
	not ass.			-0.14	7.96	0.89	0.00	0.03	-0.08	0.07
Upminster	assumed	0.00	0.99	-0.25	8.00	0.81	-0.01	0.03	-0.07	0.06

	not ass.			-0.25	7.78	0.81	-0.01	0.03	-0.07	0.06
South Harrow	assumed	0.23	0.65	-0.61	8.00	0.56	-0.02	0.03	-0.09	0.05
	not ass.			-0.61	7.49	0.56	-0.02	0.03	-0.09	0.05
Ilford	assumed	5.03	0.06	-0.80	8.00	0.45	-0.01	0.02	-0.05	0.02
	not ass.			-0.80	5.59	0.46	-0.01	0.02	-0.05	0.03
Stoke Newington	assumed	0.61	0.46	-0.16	8.00	0.87	-0.01	0.03	-0.08	0.07
	not ass.			-0.16	7.65	0.87	-0.01	0.03	-0.09	0.07
Wembley Park	assumed	0.11	0.75	-0.32	8.00	0.75	-0.01	0.03	-0.09	0.07
	not ass.			-0.32	8.00	0.75	-0.01	0.03	-0.09	0.07
Holloway Road	assumed	0.16	0.70	-0.16	8.00	0.88	-0.01	0.03	-0.09	0.07
	not ass.			-0.16	7.97	0.88	-0.01	0.03	-0.09	0.07
Hampstead	assumed	0.09	0.77	-0.22	8.00	0.83	-0.01	0.06	-0.14	0.12
	not ass.			-0.22	7.69	0.83	-0.01	0.06	-0.14	0.12
Cricklewood	assumed	0.18	0.68	-0.26	8.00	0.80	-0.01	0.03	-0.08	0.06
	not ass.			-0.26	8.00	0.80	-0.01	0.03	-0.08	0.06
Highgate Road	assumed	0.04	0.85	-0.48	8.00	0.64	-0.02	0.03	-0.09	0.06
	not ass.			-0.48	7.52	0.64	-0.02	0.03	-0.09	0.06
Sudbury Hill	assumed	3.80	0.09	-0.05	8.00	0.96	0.00	0.04	-0.08	0.08
	not ass.			-0.05	6.47	0.96	0.00	0.04	-0.09	0.08
Haverstock Hill	assumed	0.08	0.78	-0.27	8.00	0.79	-0.01	0.05	-0.12	0.10
	not ass.			-0.27	7.70	0.80	-0.01	0.05	-0.12	0.10
Wembley	assumed	0.56	0.47	-0.45	8.00	0.67	-0.01	0.03	-0.08	0.06
	not ass.			-0.45	7.83	0.67	-0.01	0.03	-0.08	0.06
Forest Gate	assumed	0.21	0.66	-0.27	8.00	0.79	-0.01	0.04	-0.10	0.07
	not ass.			-0.27	7.90	0.79	-0.01	0.04	-0.10	0.08
Willesden Green	assumed	0.25	0.63	-0.22	8.00	0.83	-0.01	0.04	-0.09	0.08
	not ass.			-0.22	7.85	0.83	-0.01	0.04	-0.09	0.08
Brondesbury Park	assumed	0.17	0.69	-0.31	8.00	0.77	-0.01	0.03	-0.08	0.06
	not ass.			-0.31	8.00	0.77	-0.01	0.03	-0.08	0.06
Dalston	assumed	0.31	0.59	-0.38	8.00	0.72	-0.01	0.02	-0.06	0.05
	not ass.			-0.38	7.75	0.72	-0.01	0.02	-0.06	0.05
West Hampstead	assumed	0.17	0.69	-0.35	8.00	0.73	-0.01	0.03	-0.07	0.05
	not ass.			-0.35	7.47	0.73	-0.01	0.03	-0.07	0.05
England's Lane	assumed	0.07	0.80	-0.15	8.00	0.88	-0.01	0.03	-0.08	0.07
	not ass.			-0.15	7.24	0.88	-0.01	0.03	-0.08	0.07
Hackney	assumed	0.50	0.50	-0.28	8.00	0.78	-0.01	0.04	-0.09	0.07
	not ass.			-0.28	7.61	0.78	-0.01	0.04	-0.09	0.07
Dagenham	assumed	1.19	0.31	-0.53	8.00	0.61	-0.01	0.02	-0.06	0.04
	not ass.			-0.53	6.54	0.61	-0.01	0.02	-0.07	0.04

Kentish Town	assumed	0.13	0.72	-0.30	8.00	0.77	-0.01	0.04	-0.09	0.07
	not ass.			-0.30	7.27	0.77	-0.01	0.04	-0.09	0.07
Finchley Road,Swiss Cottage	assumed	0.01	0.91	-0.39	8.00	0.71	-0.01	0.03	-0.08	0.05
	not ass.			-0.39	7.55	0.71	-0.01	0.03	-0.08	0.05
Stratford	assumed	2.79	0.13	-0.64	8.00	0.54	-0.01	0.02	-0.07	0.04
	not ass.			-0.64	6.32	0.55	-0.01	0.02	-0.07	0.04
Caledonian Road	assumed	0.08	0.78	-0.56	8.00	0.59	-0.02	0.03	-0.09	0.05
	not ass.			-0.56	7.56	0.59	-0.02	0.03	-0.09	0.05
Barking	assumed	2.03	0.19	-0.52	8.00	0.62	-0.01	0.03	-0.07	0.05
	not ass.			-0.52	6.24	0.62	-0.01	0.03	-0.07	0.05
Uxbridge	assumed	0.01	0.94	-0.81	8.00	0.44	-0.02	0.02	-0.06	0.03
	not ass.			-0.81	7.79	0.44	-0.02	0.02	-0.06	0.03
Upton Park	assumed	0.88	0.37	-0.13	8.00	0.90	0.00	0.03	-0.07	0.06
	not ass.			-0.13	7.44	0.90	0.00	0.03	-0.07	0.06
Kilburn	assumed	0.09	0.77	-0.33	8.00	0.75	-0.01	0.03	-0.07	0.05
	not ass.			-0.33	7.86	0.75	-0.01	0.03	-0.07	0.05
East Ham	assumed	2.01	0.19	-0.47	8.00	0.65	-0.01	0.02	-0.06	0.04
	not ass.			-0.47	6.58	0.66	-0.01	0.02	-0.06	0.04
Kensal Rise	assumed	0.46	0.51	-0.33	8.00	0.75	-0.01	0.04	-0.10	0.08
	not ass.			-0.33	6.83	0.75	-0.01	0.04	-0.10	0.08
Bow	assumed	0.16	0.70	-0.19	8.00	0.86	-0.01	0.05	-0.11	0.10
	not ass.			-0.19	7.86	0.86	-0.01	0.05	-0.11	0.10
Harlesden	assumed	0.47	0.51	-0.44	8.00	0.67	-0.01	0.02	-0.05	0.03
	not ass.			-0.44	7.82	0.67	-0.01	0.02	-0.05	0.03
Camden Town	assumed	0.15	0.71	-0.43	8.00	0.68	-0.02	0.04	-0.10	0.07
	not ass.			-0.43	7.30	0.68	-0.02	0.04	-0.10	0.07
St Johns Wood	assumed	0.05	0.82	-0.31	8.00	0.76	-0.01	0.05	-0.12	0.09
	not ass.			-0.31	7.98	0.76	-0.01	0.05	-0.12	0.09
Bethnal Green	assumed	0.03	0.87	-0.22	8.00	0.83	-0.01	0.04	-0.09	0.07
	not ass.			-0.22	8.00	0.83	-0.01	0.04	-0.09	0.07
Maida Vale	assumed	0.23	0.64	-0.25	8.00	0.81	-0.01	0.03	-0.08	0.06
	not ass.			-0.25	8.00	0.81	-0.01	0.03	-0.08	0.06
Kensal Town	assumed	0.15	0.71	-0.26	8.00	0.80	-0.01	0.03	-0.07	0.05
	not ass.			-0.26	7.80	0.80	-0.01	0.03	-0.07	0.05
Greenford	assumed	0.00	0.95	-0.69	8.00	0.51	-0.01	0.01	-0.04	0.02
	not ass.			-0.69	7.94	0.51	-0.01	0.01	-0.04	0.02
Maida Hill	assumed	0.82	0.39	-0.31	8.00	0.77	-0.01	0.03	-0.08	0.06
	not ass.			-0.31	7.65	0.77	-0.01	0.03	-0.08	0.06
Mile End Road	assumed	0.37	0.56	-0.52	8.00	0.62	-0.02	0.04	-0.11	0.07

	not ass.			-0.52	7.91	0.62	-0.02	0.04	-0.11	0.07
North Kensington	assumed	0.10	0.77	-0.19	8.00	0.85	0.00	0.02	-0.06	0.05
	not ass.			-0.19	7.66	0.85	0.00	0.02	-0.06	0.05
Limehouse	assumed	0.32	0.59	-0.41	8.00	0.69	-0.02	0.04	-0.10	0.07
	not ass.			-0.41	7.81	0.69	-0.02	0.04	-0.10	0.07
Yiewsley	assumed	0.00	1.00	-0.74	8.00	0.48	-0.02	0.03	-0.09	0.05
	not ass.			-0.74	7.78	0.48	-0.02	0.03	-0.09	0.05
Ealing	assumed	0.23	0.64	-0.47	8.00	0.65	-0.01	0.03	-0.08	0.05
	not ass.			-0.47	7.98	0.65	-0.01	0.03	-0.08	0.05
Southall	assumed	0.29	0.60	-0.13	8.00	0.90	0.00	0.04	-0.09	0.08
	not ass.			-0.13	7.88	0.90	0.00	0.04	-0.09	0.08
Acton	assumed	0.10	0.76	-0.24	8.00	0.81	-0.01	0.03	-0.08	0.07
	not ass.			-0.24	7.98	0.81	-0.01	0.03	-0.08	0.07
Stanley Gardens	assumed	0.14	0.72	-0.36	8.00	0.73	-0.01	0.03	-0.08	0.06
	not ass.			-0.36	7.07	0.73	-0.01	0.03	-0.08	0.06
Askew Road	assumed	0.24	0.64	-0.38	8.00	0.71	-0.01	0.03	-0.07	0.05
	not ass.			-0.38	7.37	0.71	-0.01	0.03	-0.07	0.05
Hayes Town	assumed	0.00	0.97	-0.41	8.00	0.69	-0.01	0.03	-0.07	0.05
	not ass.			-0.41	7.68	0.69	-0.01	0.03	-0.07	0.05
Canary Wharf	assumed	1.24	0.30	-0.73	8.00	0.49	-0.03	0.05	-0.14	0.07
	not ass.			-0.73	7.50	0.49	-0.03	0.05	-0.14	0.07
Woolwich	assumed	1.23	0.30	-0.46	8.00	0.66	-0.01	0.03	-0.08	0.05
	not ass.			-0.46	6.97	0.66	-0.01	0.03	-0.08	0.05
Erith	assumed	0.00	0.97	-0.10	8.00	0.92	0.00	0.03	-0.08	0.08
	not ass.			-0.10	7.99	0.92	0.00	0.03	-0.08	0.08
West London	assumed	0.31	0.59	-0.46	8.00	0.66	-0.01	0.03	-0.09	0.06
	not ass.			-0.46	7.22	0.66	-0.01	0.03	-0.09	0.06
Walworth	assumed	0.88	0.38	-0.45	8.00	0.66	-0.01	0.03	-0.07	0.05
	not ass.			-0.45	7.49	0.66	-0.01	0.03	-0.07	0.05
Brentford	assumed	0.01	0.94	-0.33	8.00	0.75	-0.01	0.04	-0.10	0.08
	not ass.			-0.33	7.87	0.75	-0.01	0.04	-0.10	0.08
Oval	assumed	0.72	0.42	-0.66	8.00	0.53	-0.02	0.03	-0.08	0.05
	not ass.			-0.66	7.96	0.53	-0.02	0.03	-0.08	0.05
Greenwich	assumed	0.53	0.49	-0.30	8.00	0.77	-0.01	0.02	-0.06	0.05
	not ass.			-0.30	7.86	0.77	-0.01	0.02	-0.06	0.05
Battersea Riverside	assumed	0.26	0.63	-0.36	8.00	0.73	-0.02	0.05	-0.13	0.10
	not ass.			-0.36	7.67	0.73	-0.02	0.05	-0.14	0.10
Deptford	assumed	0.01	0.92	-0.22	8.00	0.83	-0.01	0.03	-0.08	0.07
	not ass.			-0.22	7.99	0.83	-0.01	0.03	-0.08	0.07

Munster Road,Fulham	assumed	0.00	0.99	-0.40	8.00	0.70	-0.02	0.04	-0.10	0.07
	not ass.			-0.40	7.44	0.70	-0.02	0.04	-0.10	0.07
Central London	assumed	0.22	0.65	-0.65	8.00	0.53	-0.02	0.03	-0.10	0.05
	not ass.			-0.65	7.92	0.53	-0.02	0.03	-0.10	0.05
Battersea	assumed	0.21	0.66	-0.57	8.00	0.58	-0.01	0.02	-0.07	0.04
	not ass.			-0.57	7.98	0.58	-0.01	0.02	-0.07	0.04
Barnes High Street	assumed	0.00	0.98	-0.34	8.00	0.75	-0.01	0.04	-0.09	0.07
	not ass.			-0.34	7.50	0.75	-0.01	0.04	-0.10	0.07
Sands End	assumed	0.00	0.97	-0.21	8.00	0.84	-0.01	0.03	-0.07	0.06
	not ass.			-0.21	7.53	0.84	-0.01	0.03	-0.08	0.06
Latchmere Road,Battersea	assumed	0.12	0.73	-0.33	8.00	0.75	-0.01	0.04	-0.10	0.07
	not ass.			-0.33	7.45	0.75	-0.01	0.04	-0.10	0.08
Camberwell	assumed	0.00	0.98	-0.21	8.00	0.84	-0.01	0.06	-0.14	0.12
	not ass.			-0.21	7.99	0.84	-0.01	0.06	-0.14	0.12
Peckham	assumed	2.52	0.15	-0.47	8.00	0.65	-0.01	0.02	-0.05	0.03
	not ass.			-0.47	6.02	0.65	-0.01	0.02	-0.05	0.04
Barnes	assumed	0.00	0.99	-0.48	8.00	0.64	-0.02	0.03	-0.10	0.06
	not ass.			-0.48	7.58	0.64	-0.02	0.03	-0.10	0.06
Blackheath	assumed	0.18	0.68	-0.33	8.00	0.75	-0.01	0.03	-0.09	0.07
	not ass.			-0.33	7.99	0.75	-0.01	0.03	-0.09	0.07
Fulham	assumed	0.00	0.99	-0.25	8.00	0.81	-0.01	0.03	-0.08	0.07
	not ass.			-0.25	7.36	0.81	-0.01	0.03	-0.08	0.07
Welling	assumed	0.32	0.59	-0.07	8.00	0.94	0.00	0.03	-0.06	0.06
	not ass.			-0.07	7.87	0.94	0.00	0.03	-0.06	0.06
Heathrow	assumed	0.72	0.42	-0.36	8.00	0.73	-0.02	0.05	-0.13	0.09
	not ass.			-0.36	7.35	0.73	-0.02	0.05	-0.13	0.09
Lavender Hill	assumed	0.25	0.63	-0.23	8.00	0.83	-0.01	0.03	-0.07	0.06
	not ass.			-0.23	7.99	0.83	-0.01	0.03	-0.07	0.06
Hounslow	assumed	0.14	0.72	-0.78	8.00	0.46	-0.01	0.02	-0.05	0.03
	not ass.			-0.78	7.94	0.46	-0.01	0.02	-0.05	0.03
East Sheen	assumed	0.09	0.78	-0.42	8.00	0.69	-0.01	0.03	-0.08	0.05
	not ass.			-0.42	7.68	0.69	-0.01	0.03	-0.08	0.05
Clapham	assumed	0.38	0.55	-0.31	8.00	0.77	-0.01	0.04	-0.10	0.07
	not ass.			-0.31	7.85	0.77	-0.01	0.04	-0.10	0.07
Lewisham	assumed	0.67	0.44	-0.46	8.00	0.66	-0.01	0.03	-0.09	0.06
	not ass.			-0.46	7.72	0.66	-0.01	0.03	-0.09	0.06
Brixton	assumed	1.70	0.23	-0.40	8.00	0.70	-0.01	0.03	-0.07	0.05
	not ass.			-0.40	6.75	0.70	-0.01	0.03	-0.08	0.05
Bexleyheath	assumed	2.39	0.16	-0.38	8.00	0.72	-0.01	0.01	-0.04	0.03

	not ass.			-0.38	5.81	0.72	-0.01	0.01	-0.04	0.03
East Dulwich	assumed	0.03	0.87	-0.13	8.00	0.90	0.00	0.03	-0.07	0.06
	not ass.			-0.13	8.00	0.90	0.00	0.03	-0.07	0.06
Lee Green,Lewisham	assumed	0.05	0.83	-0.22	8.00	0.83	-0.01	0.04	-0.09	0.08
	not ass.			-0.22	8.00	0.83	-0.01	0.04	-0.09	0.08
Putney	assumed	0.08	0.78	-0.51	8.00	0.63	-0.01	0.02	-0.07	0.04
	not ass.			-0.51	7.86	0.63	-0.01	0.02	-0.07	0.04
Clapham Junction	assumed	0.18	0.69	-0.30	8.00	0.77	-0.01	0.02	-0.06	0.05
	not ass.			-0.30	7.94	0.77	-0.01	0.02	-0.06	0.05
Crayford	assumed	0.64	0.45	-0.14	8.00	0.89	0.00	0.02	-0.05	0.05
	not ass.			-0.14	7.23	0.89	0.00	0.02	-0.06	0.05
Richmond,London	assumed	0.10	0.76	-0.46	8.00	0.66	-0.01	0.03	-0.07	0.05
	not ass.			-0.46	7.58	0.66	-0.01	0.03	-0.07	0.05
Wandsworth	assumed	0.40	0.54	-0.53	8.00	0.61	-0.01	0.03	-0.07	0.04
	not ass.			-0.53	8.00	0.61	-0.01	0.03	-0.07	0.04
Richmond Bridge	assumed	0.27	0.62	-0.39	8.00	0.70	-0.01	0.04	-0.10	0.07
	not ass.			-0.39	7.34	0.71	-0.01	0.04	-0.10	0.07
Eltham	assumed	0.13	0.73	-0.38	8.00	0.71	0.00	0.01	-0.03	0.02
	not ass.			-0.38	7.57	0.71	0.00	0.01	-0.03	0.02
St Margarets	assumed	0.13	0.72	-0.22	8.00	0.83	-0.01	0.04	-0.10	0.08
	not ass.			-0.22	7.36	0.83	-0.01	0.04	-0.10	0.08
Catford	assumed	4.57	0.07	-0.68	8.00	0.51	-0.02	0.02	-0.07	0.04
	not ass.			-0.68	5.84	0.52	-0.02	0.02	-0.07	0.04
Twickenham	assumed	0.03	0.86	-0.35	8.00	0.73	-0.01	0.02	-0.07	0.05
	not ass.			-0.35	6.85	0.73	-0.01	0.02	-0.07	0.05
Balham	assumed	0.07	0.80	-0.21	8.00	0.84	-0.01	0.04	-0.11	0.09
	not ass.			-0.21	7.99	0.84	-0.01	0.04	-0.11	0.09
Forest Hill	assumed	0.13	0.73	-0.28	8.00	0.79	-0.01	0.04	-0.10	0.08
	not ass.			-0.28	7.96	0.79	-0.01	0.04	-0.10	0.08
Feltham	assumed	3.20	0.11	-0.75	8.00	0.48	-0.01	0.02	-0.06	0.03
	not ass.			-0.75	6.25	0.48	-0.01	0.02	-0.06	0.03
Station Road, Sidcup	assumed	0.33	0.58	-0.47	8.00	0.65	-0.02	0.03	-0.09	0.06
	not ass.			-0.47	7.88	0.65	-0.02	0.03	-0.09	0.06
Upper Tooting	assumed	0.01	0.92	-0.33	8.00	0.75	-0.02	0.05	-0.13	0.10
	not ass.			-0.33	7.98	0.75	-0.02	0.05	-0.13	0.10
West Norwood	assumed	0.07	0.80	-0.14	8.00	0.90	-0.01	0.04	-0.11	0.10
	not ass.			-0.14	7.99	0.90	-0.01	0.04	-0.11	0.10
Sidcup	assumed	0.54	0.48	-0.54	8.00	0.60	-0.02	0.03	-0.10	0.06
	not ass.			-0.54	7.81	0.60	-0.02	0.03	-0.10	0.06

Sydenham	assumed	0.15	0.71	-0.22	8.00	0.83	-0.01	0.03	-0.08	0.06
	not ass.			-0.22	8.00	0.83	-0.01	0.03	-0.08	0.06
Streatham	assumed	0.54	0.48	-0.29	8.00	0.78	-0.01	0.03	-0.07	0.05
	not ass.			-0.29	7.77	0.78	-0.01	0.03	-0.07	0.06
Tooting	assumed	0.02	0.88	-0.40	8.00	0.70	-0.01	0.04	-0.10	0.07
	not ass.			-0.40	7.99	0.70	-0.01	0.04	-0.10	0.07
Wimbledon Village	assumed	0.00	0.99	-0.28	8.00	0.78	-0.01	0.04	-0.11	0.09
	not ass.			-0.28	7.75	0.78	-0.01	0.04	-0.11	0.09
Chislehurst	assumed	0.00	0.97	-0.29	8.00	0.78	-0.01	0.03	-0.07	0.05
	not ass.			-0.29	7.59	0.78	-0.01	0.03	-0.07	0.05
Teddington	assumed	0.01	0.91	-0.45	8.00	0.66	-0.01	0.02	-0.07	0.05
	not ass.			-0.45	7.28	0.66	-0.01	0.02	-0.07	0.05
Upper Norwood	assumed	0.28	0.61	-0.36	8.00	0.73	-0.01	0.03	-0.09	0.07
	not ass.			-0.36	7.97	0.73	-0.01	0.03	-0.09	0.07
Wimbledon	assumed	0.30	0.60	-0.43	8.00	0.68	-0.01	0.02	-0.06	0.04
	not ass.			-0.43	7.98	0.68	-0.01	0.02	-0.06	0.04
Penge	assumed	0.07	0.80	-0.37	8.00	0.72	-0.01	0.02	-0.06	0.04
	not ass.			-0.37	7.99	0.72	-0.01	0.02	-0.06	0.04
Hampton Wick	assumed	0.02	0.89	-0.48	8.00	0.65	-0.02	0.04	-0.10	0.07
	not ass.			-0.48	7.61	0.65	-0.02	0.04	-0.10	0.07
Raynes Park	assumed	0.06	0.81	-0.49	8.00	0.63	-0.01	0.03	-0.08	0.05
	not ass.			-0.49	7.24	0.64	-0.01	0.03	-0.08	0.05
Norbiton	assumed	0.35	0.57	-0.36	8.00	0.73	-0.01	0.03	-0.08	0.06
	not ass.			-0.36	7.01	0.73	-0.01	0.03	-0.08	0.06
Beckenham	assumed	0.01	0.93	-0.34	8.00	0.74	-0.01	0.04	-0.10	0.07
	not ass.			-0.34	7.97	0.74	-0.01	0.04	-0.10	0.07
Norbury	assumed	0.84	0.39	-0.31	8.00	0.76	-0.01	0.04	-0.11	0.08
	not ass.			-0.31	7.32	0.76	-0.01	0.04	-0.11	0.08
Mitcham	assumed	0.26	0.62	-0.50	8.00	0.63	-0.02	0.03	-0.10	0.06
	not ass.			-0.50	7.91	0.63	-0.02	0.03	-0.10	0.06
Kingston-upon-Thames	assumed	1.13	0.32	-0.24	8.00	0.81	0.00	0.02	-0.05	0.04
	not ass.			-0.24	7.55	0.81	0.00	0.02	-0.05	0.04
Bromley	assumed	0.75	0.41	-0.96	8.00	0.37	-0.02	0.02	-0.05	0.02
	not ass.			-0.96	7.39	0.37	-0.02	0.02	-0.05	0.02
Morden	assumed	0.72	0.42	-0.83	8.00	0.43	-0.02	0.02	-0.07	0.03
	not ass.			-0.83	7.76	0.43	-0.02	0.02	-0.07	0.03
South Norwood	assumed	0.04	0.84	-0.30	8.00	0.77	-0.01	0.04	-0.10	0.07
	not ass.			-0.30	7.99	0.77	-0.01	0.04	-0.10	0.07
New Malden	assumed	0.39	0.55	-0.51	8.00	0.62	-0.02	0.03	-0.09	0.06

	not ass.			-0.51	7.86	0.62	-0.02	0.03	-0.09	0.06
Petts Wood	assumed	0.16	0.70	-0.30	8.00	0.77	-0.01	0.03	-0.07	0.05
	not ass.			-0.30	7.56	0.77	-0.01	0.03	-0.07	0.06
Surbiton	assumed	0.33	0.58	-0.47	8.00	0.65	-0.01	0.02	-0.07	0.04
	not ass.			-0.47	7.24	0.65	-0.01	0.02	-0.07	0.05
Tolworth	assumed	0.13	0.73	-0.65	8.00	0.53	-0.02	0.03	-0.08	0.05
	not ass.			-0.65	7.79	0.53	-0.02	0.03	-0.08	0.05
West Wickham	assumed	0.14	0.72	-0.18	8.00	0.87	0.00	0.02	-0.06	0.05
	not ass.			-0.18	7.95	0.87	0.00	0.02	-0.06	0.05
Orpington	assumed	0.27	0.62	-0.65	8.00	0.54	-0.01	0.02	-0.05	0.03
	not ass.			-0.65	7.98	0.54	-0.01	0.02	-0.05	0.03
Worcester Park	assumed	0.05	0.83	-0.49	8.00	0.64	-0.01	0.02	-0.06	0.04
	not ass.			-0.49	7.80	0.64	-0.01	0.02	-0.06	0.04
North Cheam	assumed	0.04	0.85	-0.45	8.00	0.66	-0.01	0.02	-0.06	0.04
	not ass.			-0.45	7.76	0.66	-0.01	0.02	-0.06	0.04
Croydon	assumed	0.31	0.59	-1.05	8.00	0.33	-0.02	0.02	-0.06	0.02
	not ass.			-1.05	7.87	0.33	-0.02	0.02	-0.06	0.02
Wallington	assumed	0.36	0.56	-0.61	8.00	0.56	-0.02	0.03	-0.08	0.05
	not ass.			-0.61	7.99	0.56	-0.02	0.03	-0.08	0.05
Cheam	assumed	0.19	0.68	-0.50	8.00	0.63	-0.01	0.03	-0.08	0.05
	not ass.			-0.50	7.93	0.63	-0.01	0.03	-0.08	0.05
Purley	assumed	0.05	0.83	-0.57	8.00	0.58	-0.01	0.02	-0.06	0.03
	not ass.			-0.57	7.93	0.58	-0.01	0.02	-0.06	0.03
Coulsdon	assumed	0.02	0.90	-0.33	8.00	0.75	-0.01	0.02	-0.06	0.05
	not ass.			-0.33	7.34	0.75	-0.01	0.02	-0.06	0.05
Angel,Islington	assumed	0.93	0.36	-0.49	8.00	0.64	-0.01	0.03	-0.07	0.05
	not ass.			-0.49	7.85	0.64	-0.01	0.03	-0.07	0.05
Camden High Street	assumed	0.16	0.70	-0.44	8.00	0.67	-0.02	0.04	-0.10	0.07
	not ass.			-0.44	7.30	0.68	-0.02	0.04	-0.10	0.07
Shoreditch	assumed	0.10	0.76	-0.62	8.00	0.56	-0.02	0.03	-0.10	0.06
	not ass.			-0.62	7.36	0.56	-0.02	0.03	-0.10	0.06
Edgware Road	assumed	0.13	0.73	-0.52	8.00	0.62	-0.02	0.03	-0.09	0.06
	not ass.			-0.52	7.84	0.62	-0.02	0.03	-0.09	0.06
Holborn	assumed	0.01	0.93	-0.73	8.00	0.49	-0.03	0.04	-0.12	0.06
	not ass.			-0.73	7.67	0.49	-0.03	0.04	-0.12	0.06
Liverpool Street and Bishopsgate	assumed	0.54	0.48	-0.60	8.00	0.56	-0.04	0.06	-0.17	0.10
	not ass.			-0.60	7.84	0.56	-0.04	0.06	-0.17	0.10
Portobello Road	assumed	0.01	0.94	0.15	8.00	0.89	0.00	0.02	-0.04	0.05
	not ass.			0.15	8.00	0.89	0.00	0.02	-0.04	0.05

Westbourne Grove	assumed	0.02	0.90	0.01	8.00	0.99	0.00	0.03	-0.06	0.06
	not ass.			0.01	7.88	0.99	0.00	0.03	-0.06	0.06
Cheapside	assumed	0.45	0.52	-0.60	8.00	0.57	-0.04	0.06	-0.18	0.10
	not ass.			-0.60	7.89	0.57	-0.04	0.06	-0.18	0.10
Leadenhall	assumed	0.48	0.51	-0.57	8.00	0.58	-0.04	0.06	-0.18	0.11
	not ass.			-0.57	7.83	0.58	-0.04	0.06	-0.18	0.11
Bayswater	assumed	0.00	0.99	0.00	8.00	1.00	0.00	0.04	-0.08	0.08
	not ass.			0.00	7.89	1.00	0.00	0.04	-0.08	0.08
Notting Hill Gate	assumed	0.00	0.95	-0.31	8.00	0.76	-0.01	0.03	-0.08	0.06
	not ass.			-0.31	7.70	0.76	-0.01	0.03	-0.08	0.06
West End,London	assumed	0.03	0.87	-0.62	8.00	0.55	-0.02	0.03	-0.09	0.05
	not ass.			-0.62	7.65	0.55	-0.02	0.03	-0.09	0.05
Kensington High Street	assumed	0.01	0.91	-0.33	8.00	0.75	-0.01	0.03	-0.07	0.05
	not ass.			-0.33	7.83	0.75	-0.01	0.03	-0.07	0.05
Knightsbridge	assumed	0.00	0.96	-0.19	8.00	0.86	-0.01	0.04	-0.10	0.08
	not ass.			-0.19	7.96	0.86	-0.01	0.04	-0.10	0.08
Victoria	assumed	0.43	0.53	-0.73	8.00	0.49	-0.02	0.03	-0.10	0.05
	not ass.			-0.73	8.00	0.49	-0.02	0.03	-0.10	0.05
South Kensington	assumed	0.38	0.55	-0.07	8.00	0.95	0.00	0.03	-0.07	0.07
	not ass.			-0.07	7.82	0.95	0.00	0.03	-0.07	0.07
Upper Brompton Road	assumed	0.46	0.51	-0.07	8.00	0.95	0.00	0.03	-0.07	0.07
	not ass.			-0.07	7.73	0.95	0.00	0.03	-0.07	0.07
Pimlico	assumed	0.09	0.77	-0.76	8.00	0.47	-0.03	0.03	-0.11	0.05
	not ass.			-0.76	7.99	0.47	-0.03	0.03	-0.11	0.05
Chiswick	assumed	0.03	0.86	-0.27	8.00	0.80	-0.01	0.03	-0.08	0.06
	not ass.			-0.27	7.01	0.80	-0.01	0.03	-0.08	0.06
Hammersmith	assumed	0.51	0.50	-0.41	8.00	0.69	-0.02	0.04	-0.11	0.08
	not ass.			-0.41	7.42	0.69	-0.02	0.04	-0.11	0.08
Kings Road,Chelsea	assumed	0.02	0.90	-0.24	8.00	0.81	-0.01	0.04	-0.09	0.08
	not ass.			-0.24	7.93	0.81	-0.01	0.04	-0.09	0.08
Fulham Retail Core	assumed	0.02	0.88	-0.27	8.00	0.80	-0.01	0.03	-0.07	0.06
	not ass.			-0.27	7.70	0.80	-0.01	0.03	-0.07	0.06
Croydon Retail Core	assumed	0.70	0.43	-0.89	8.00	0.40	-0.02	0.02	-0.06	0.03
	not ass.			-0.89	7.67	0.40	-0.02	0.02	-0.06	0.03

11.10 Pearson's correlation index of location recommendations

11.10.1 Scenario 1

UCL

Correlations

		UCL - User 1	UCL - User 2	UCL - User 3	UCL - User 4	UCL - User 5
UCL - User 1	Pearson Correlation	1	.779**	.777**	.638**	.571**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
UCL - User 2	Pearson Correlation	.779**	1	.855**	.595**	.774**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
UCL - User 3	Pearson Correlation	.777**	.855**	1	.647**	.832**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
UCL - User 4	Pearson Correlation	.638**	.595**	.647**	1	.560**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
UCL - User 5	Pearson Correlation	.571**	.774**	.832**	.560**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Think London

Correlations

		TL - User 1	TL - User 2	TL - User 3	TL - User 4	TL - User 5
TL - User 1	Pearson Correlation	1	.884**	.927**	.546**	.939**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
TL - User 2	Pearson Correlation	.884**	1	.819**	.440**	.951**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
TL - User 3	Pearson Correlation	.927**	.819**	1	.756**	.821**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
TL - User 4	Pearson Correlation	.546**	.440**	.756**	1	.433**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
TL - User 5	Pearson Correlation	.939**	.951**	.821**	.433**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

11.10.2 Scenario 2

UCL

Correlations

		UCL - User 1	UCL - User 2	UCL - User 3	UCL - User 4	UCL - User 5
UCL - User 1	Pearson Correlation	1	.691**	.682**	.494**	.520**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
UCL - User 2	Pearson Correlation	.691**	1	.891**	.858**	.883**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
UCL - User 3	Pearson Correlation	.682**	.891**	1	.933**	.963**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
UCL - User 4	Pearson Correlation	.494**	.858**	.933**	1	.930**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
UCL - User 5	Pearson Correlation	.520**	.883**	.963**	.930**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Think London

Correlations

		TL - User 1	TL - User 2	TL - User 3	TL - User 4	TL - User 5
TL - User 1	Pearson Correlation	1	.879**	.834**	.879**	.934**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
TL - User 2	Pearson Correlation	.879**	1	.939**	1.000**	.934**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
TL - User 3	Pearson Correlation	.834**	.939**	1	.939**	.922**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
TL - User 4	Pearson Correlation	.879**	1.000**	.939**	1	.934**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
TL - User 5	Pearson Correlation	.934**	.934**	.922**	.934**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

11.10.3 Scenario 3

UCL

Correlations

		UCL - User 1	UCL - User 2	UCL - User 3	UCL - User 4	UCL - User 5
UCL - User 1	Pearson Correlation	1	.958**	.844**	.950**	.935**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
UCL - User 2	Pearson Correlation	.958**	1	.709**	.931**	.980**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
UCL - User 3	Pearson Correlation	.844**	.709**	1	.804**	.730**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
UCL - User 4	Pearson Correlation	.950**	.931**	.804**	1	.917**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
UCL - User 5	Pearson Correlation	.935**	.980**	.730**	.917**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Think London

Correlations

		TL - User 1	TL - User 2	TL - User 3	TL - User 4	TL - User 5
TL - User 1	Pearson Correlation	1	.888**	.749**	.888**	.865**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	208	208	208	208	208
TL - User 2	Pearson Correlation	.888**	1	.727**	1.000**	.996**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	208	208	208	208	208
TL - User 3	Pearson Correlation	.749**	.727**	1	.727**	.728**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	208	208	208	208	208
TL - User 4	Pearson Correlation	.888**	1.000**	.727**	1	.996**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	208	208	208	208	208
TL - User 5	Pearson Correlation	.865**	.996**	.728**	.996**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

11.11 Commercialisation hypotheses

The following exploration of these commercialisation and development hypotheses is guided by the customer discovery philosophy developed in the "Four Steps to Epiphany" (Blank 2005). This book aims to develop a novel approach to entrepreneurial product development, focusing on the early product development phase, guided by the need for a clear vision of the projected service to guide both product and customer development. This vision entails the product features, likely first customers, the channel and pricing, how to create demand, the market type and likely competition. These are only assumptions that need to be tested and if necessary amended in an iterative fashion, but serve as a useful first step to evaluate the business potential and likely development process into commercial product of this research project. In the context of this research thesis, the development of these initial hypotheses framework helps guide and explore some commercialisation issues likely to be encountered in the development of a commercial "*business location recommendation service*":

11.11.1 Product Hypotheses

The product hypothesis consists of some initial guesses about the product and its development. The final product would be a web based dynamic and rich spatial decision support system, i.e. a business location recommendation service, guiding and supporting the user through the location decision-making process according to individual needs and demands. The **key features** that constitute this service:

- The capture through an easy to use web questionnaire of a user's location preferences;
- The automated analysis and generation of location recommendations according to investors preferences, making use of the products rich knowledge base of:
    - A comprehensive spatial database of key locations and decision variables relevant to business location decision-making;
    - The classification and characterisation of locations into several business environments from the spatial database;
- The interactive exploration of location recommendations, including the analysis and comparison of location options according to different metrics;
- The integration and presentation of external datasets such as property offers;
- The generation of reports and other outputs for users to share location recommendations.

Through this succinct description of the proposed service, the qualification of the **benefits to customers** then also becomes possible:

- Explore unfamiliar locations for their business potential according to individual business requirements.
- Understanding, comparing and ranking the market potential of different locations.
- Make better location decisions as a consequence.

11.11.2 Customer & problem hypotheses

The assumptions covered in this section cover two key areas: who the customers are, and what problems they have. The classification of potential customers can be seen on two levels for this project: First, the **types of companies** which the product could help, and secondly the different **types of users or decision makers** influencing the adoption of the proposed product.

Given that the service is a business oriented service for location decision-making, the most likely clients benefiting and using the service would be companies that have not the resources to either afford inhouse or contracted location consultants creating bespoke location analysis reports. The companies which are likely targeted as prospective clients would be:

- New Businesses and start-ups looking to setup a first location for their new business.
- Small to Medium Entreprises (SME's) looking to expand or relocate their activities. They would be looking to identify suitable prospect locations to expand or relocate their business acitivites.

Inside these different businesses for which the location decision support service would be useful, there are different types of users which need to be understood in the product development process:

- **End Users**: These can range in startup's from the business founder making the location decisions or the researcher in SME's tasked with evaluating and creating a shortlist of potential new locations.
- **Influencers & Recommenders**: Other actors influencing the decision of using the service can include external partners and advisors of the end users which could recommend and promote usage of the product.
- **Economic buyer & Decision Maker**: The person inside an organisation which has the final say about paying for the usage of the service can be different from the end user.

In smaller enterprises, end user and decision maker might well be the same person, but can also be the firm founder, chief executive or line manager of the end user.

Apart from an understanding of the different types of actors, **customer type interactions** and consequences for the sales process also need to be understood. The interactions between end users, influencers and recommenders in the sales and marketing process serve then as a useful road map for the customer targeting and sales map, but need to be formulated through discussions with potential customers at a later stage of the development process.

The **customer problems** section addresses the problem that this service is trying to solve, in other words, what is the customer pain addressed and resolved by the service. This not only includes the specific solution benefits, but also the level of awareness of the problem, the importance for the business, as well as the likely ROI of the service for the customer. These issues are addressed in the next section:

The bulk of commercial location decision-making support to date has been through bespoke consultancy from property agents, site consultants, and other business services companies that serve mainly large multinational enterprises that can afford expensive consultancy. Help and advice for smaller investors lacking the resources to approach such consultancies, could be provided by this service, enabling the exploration and prioritisation of an heterogeneous and unfamiliar business landscape for business location decision-making then proves to still be a challenge for most companies.

The business location decision support should allow businesses to improve their site selection process significantly. Built on top of mostly public domain datasets, the tool offers a highly interactive but guided approach to exploring and understanding both the business location decision variables for the client, as well as presenting the business location landscape in a structured geographic framework. These decisions affect specifically in the context of start-ups and SME's the whole business and are potentially vital to the success or failure of the business as a whole. It is likely though that most small businesses do at the moment not have in place detailed methodologies for the evaluation of different locations. They likely are aware that their business location has a significant impact on their firm's business prospects, but have so far not addressed the problem in a serious manner. A location decision support service then offers a convenient and effective site selection tool, a low cost approach to quantify and qualify potential business locations according to individual business needs. The main benefit that a customer stands to gain from the service then are better and more informed business location decisions.

Although there are clear benefits for a firm using the proposed service, the mission-critical nature or not of better location decisions will depend on the company activities: location decisions will probably be mission-critical for a retail business, less likely so for a internet startup. The nature of the customer problems and the solution proposed by this service also needs to be evaluated in the context of the customer's Return on Investment (ROI), i.e. if the customer feels that he is getting "a good deal". Given the targeted market of startup's and SME's, a detailed knowledge of the ROI for a customer will be invaluable intelligence in the formulation of a revenue model and pricing strategy. Given the general impact of business location on the business potential, a ROI for the company would have to look at the revenue potential or costs associated with different location options, to arrive at a ROI model, which can only be judged in dialog with early customers.

11.11.3 Channel and pricing hypotheses

So far, the nature of the proposed service as well as a detailed picture of the likely customers of the service has been developed. This section then deals with how to reach these customers, as well as how revenue can be generated.

The **distribution channel** not only involves the physical provision of the service, which in this case would be a relatively straightforward online web service site. It also entails the many sales and distribution channels by which customers find and use the service.

The direct sales channel is one possibility, with the service provided and sold to customers directly. Apart from the direct sales channel, there are distribution and sales partners through which the service could reach end customers:

- RDA's and FDI promotion agencies are an obvious target given the context of the development of the prototype, offering individualised location consultancy to firms looking to locate or expand in the agencies region.
- Business Property Agents that want to expand their service offer could offer business location decision support as a value-added service to their customers, as well as an attractive environment to integrate and allow clients to explore their property offer.
- Accountants, banks and other business service companies offer already all kinds of business support services to their clients. Business location decision support would be

a high value supplemental business support offer to engage with and add value to their clients.

The choice of one or several of these sales channels on the **revenue model** also needs to be considered. In the case of the aforementioned indirect channels, the service relies on sponsorship by one of the aforementioned potential partners, in which case the service could be offered as a white labelled product to be branded by individual partners.

In the case of direct sales to customers, not only could there be a subscription charge to access the service, but also usage billed on a pay-as-you-go basis. Another popular model today in web services is the "*freemium*", whereas a basic service is provided to the customer for free, but some premium features are charged, such as for example the generation of printable reports. Revenue can also be generated if the service is offered free of charge to the user. A free service would generate revenue through targeted advertising, leveraging knowledge about the user of the service, as well as referral fees for example if a user clicks through to a partners website, for example a property from an estate agents feed that a user wants to know more about.

11.11.4 Demand Creation Hypotheses

The generation of demand for a service or product is an essential part of any business. This not only entails the direct marketing to potential customers through various means, but also the identification and development of relevant sales and marketing networking involving potential partners, multipliers and influencers. Creating demand for the chosen distribution channel entails the selection and usage of marketing and sales strategies:

- **Word of Mouth**: in every market, there are **influencers** that can spread knowledge of the service and positively influence potential customers to create demand. A detailed knowledge and targeting of these influencers is essential, be it past customers, press, prominent bloggers, key leaders in an industry.
- **Advertising**: targeted advertising, online as well as in trade publications can reach a large potential customer base and generate interest in the service.
- **Partners**: Building and maintaining relationships with potential multipliers and sales partners can reach a wide selection of potential customers. These partners can refer customers to the service.

- **Targeted direct marketing**: The identification of new businesses looking to locate or existing businesses expanding from company information databases would allow focused direct marketing campaigns, e.g. email campaigns, cold calling.

11.11.5 Market Hypotheses

The **market type** is the environment in which the service will be offered to customers. There are three basic types of markets that a new service or product can enter. Entering an existing market, resegmenting an existing market or entering a new market.

Business location decision-making support has existed before the development of this new service, mostly in the shape of location consultants and bespoke consultancy projects for individual clients. The emergence of the proposed low-cost approach of providing a highly automated, yet individualised web service to offer location recommendations then represents a **resegmentation** of this existing location consultancy market. Figure 58 shows a competitive diagram highlighting how the proposed web SDSS service would resegment the market through a significantly lowered cost to customers, while retaining location analysis and selection benefits currently offered by most location consultants at a significantly higher cost. The web service would move some existing customers to abandon their location consultants, saving money while still getting relevant location analysis services.

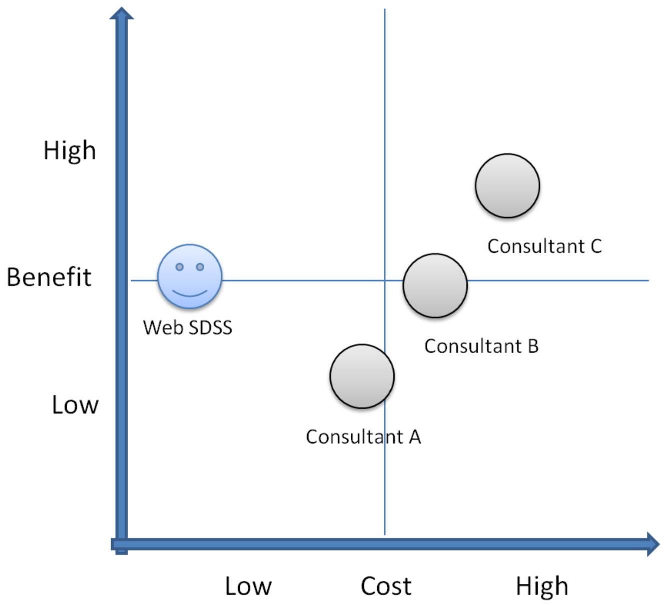


Figure 58: Competitive Diagram

Crucially, the web service low cost approach opens up opens up location analysis and benchmarking to companies which before did not have the necessary internal or external consultancy resources.

11.11.6 Competitive Hypotheses

The final aspect to investigate and develop assumptions for is the competitive landscape in which this new service would be developed, in terms of the overall trends that possibly benefit the commercial potential of a location recommendation service, potential threats from new or existing competitors and barriers of adoption for the service.

Some of the overarching trends which have made possible the development of a low-cost location recommendation service are:

- Open Data Access: the increased availability of good quality and high spatial resolution public sector datasets and database covering many aspect of business location decision.
- The need for businesses from all sectors and sizes in a highly competitive business environment to make the right business location decisions.
- Increasing FDI investments by not only large multinational conglomerates but also smaller firms with less resources.
- The delivery of business support services for domestic and foreign owned businesses by public agencies is increasingly offloaded to the private sector.

These competitive opportunities benefit the development of a successful location recommendation web service, but also apply to any competitors. Given the current lack of proprietary datasets, there is a risk of competitors entering the resegmented market and replicating the proposed web service using the same access to open datasets.

The competitive advantage setting this venture apart from existing competitors would need to come then first from being first to the market and building a customer base. This market momentum would not only be a barrier to competitors, but would also allow the development of proprietary knowledge base on businesses location decision-making processes and variables.

11.11.7 Conclusion to commercialisation

The development of this set of assumptions regarding product, customers, channel, demand and competitive market into a brief is an essential part of the evaluation of the commercialisation process and an early stage of the product development process in a startup. This exercise allowed the formulation of the commercialisation specifics for a relatively low-cost *business location recommendation service*, aimed at new and existing small to medium sized firms in a variety of sectors which need location consultancy, but which up until now didn't have the resources to afford such bespoke consultancy services.

These briefs not only provide a basis on which to write a business plan, but more importantly, enable the identification and qualification of a wide set of assumptions, serving as reference points to be tested in conjunction with early stage customers. Through the entire product and customer development process, these assumptions will serve as guiding briefs, while at the same continually and iteratively being tested and proven to be correct, or more realistically, being updated with new knowledge or rejected using customer feedback. These briefs then serve as living documents that constantly reflect the current best knowledge and progress in the development and commercialisation process.